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OCTOBER, 1941

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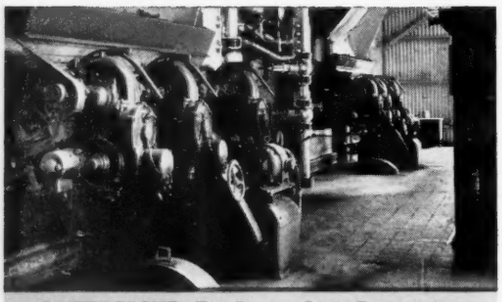
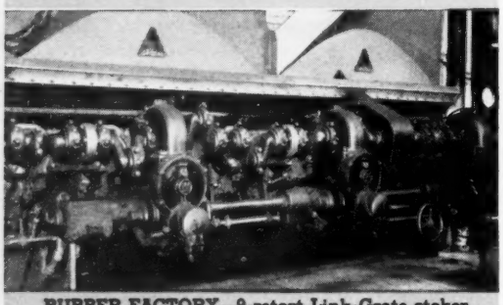
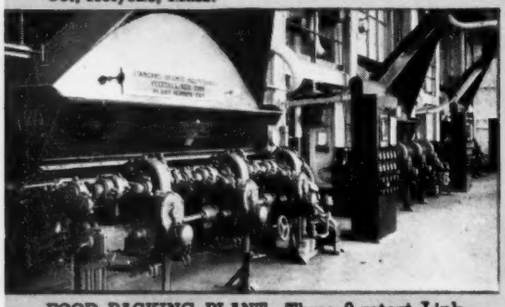


POWER PLANT—Two 7-retort Link-Grate stokers at Virginia Public Service Co., Alexandria, Va.



RUBBER FACTORY—9-retort Link-Grate stoker at Gillette Tire Plant, U. S. Rubber Co., Eau Claire, Wisconsin.

PAPER MILL—Two Link-Grate single retort stokers, with Hydrofeed drive, at Newton Paper Co., Holyoke, Mass.

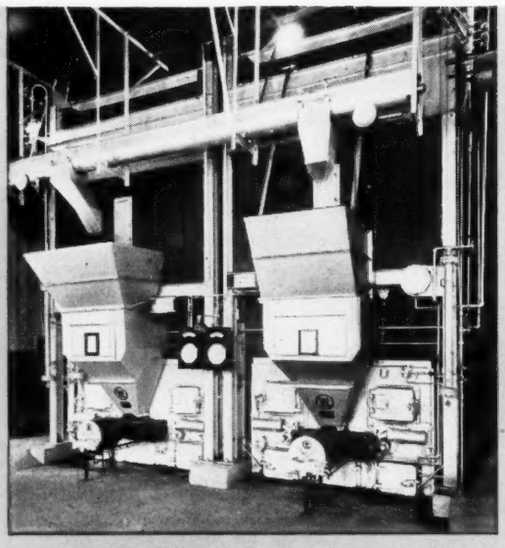


FOOD PACKING PLANT—Three 9-retort Link-Grate stokers at the plant of Standard Brands Incorporated, Peekskill, N. Y.

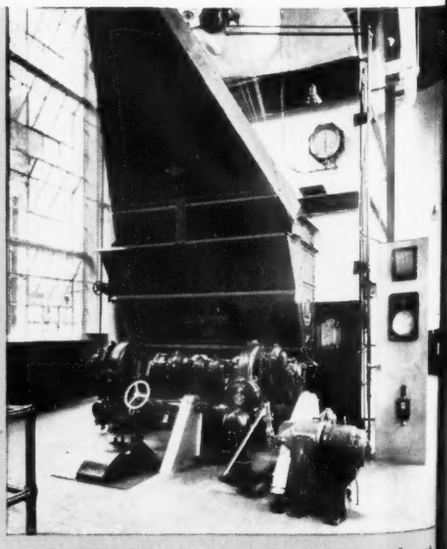
Westinghouse Stoker Experience Covers All Types of Applications

Here are Typical Users Who Have Reported Consistent Savings with Westinghouse Link-Grate Stokers:

- Power Plants
- Water Works
- Steel Mills
- Paper Mills
- Cotton Mills
- Laundries
- Oil Refineries
- Universities
- Public Buildings
- Department Stores
- General Manufacturing
- Food Packers
- Pottery Makers
- Salt Refineries
- Creameries
- Leather Tanneries
- Cement Makers
- Hospitals
- Glass Makers
- Breweries
- Distilleries
- Tobacco Companies
- Chemical Makers
- Textile Mills
- Shoe Manufacturers
- Apartment Houses
- Automobile Plants
- Publishing Companies
- Penal Institutions
- Explosive Manufacturers



HOSPITAL—Two Link-Grate single retort stokers at Louisville City Hospital, Louisville, Ky.



TEXTILE MILL—5-retort Link-Grate stoker at the Graniteville Co., Graniteville, S. C.

Westinghouse

POWER

Established 1882 • PHILIP W SWAIN, Editor

The Devil's Ally

Industrial prosperity, whether achieved under the forced draft of defense rearmament or in the normal course of good business, brings with it hazards that more leisurely production can avoid. One of the real bad actors is fire.

In normal years something over 8,000 fires occur in industrial plants, warehouses and docks. As business picks up, this number increases far more than in proportion to the value of manufactured products because new men are less careful than those accustomed to working about a plant or factory, electrical facilities are more heavily loaded, less attention is given to accumulations of rubbish, and fire extinguishing equipment gets neglected.

Fire that starts from carelessness is just as much an ally of the enemy as one lighted by his saboteurs. Fire is more to be feared within a power plant than explosion, flood or wind.

On page 72 of this issue Herbert Lange, for many years an engineer with Underwriters' Laboratories, tells some facts that aid experts in fighting fire. Two simple ideas are most important: first, the best time to fight a fire is before it starts; second, it is easier, quicker and less costly to combat a little blaze before it grows into a big one.

Fire fighting has become a specialized business. To the expert, a metal door and a steel beam are not necessarily fireproof. Electrical equipment deserves and gets a separate classification. Hazards that mean nothing to the uneducated eye loom large to those familiar with repeated reports of the causes of serious fire damage.

There will be more industrial fires this year than last; the statisticians are rarely wrong about bad news. Only careful planning and definite action will keep the number down and the seriousness at a minimum.

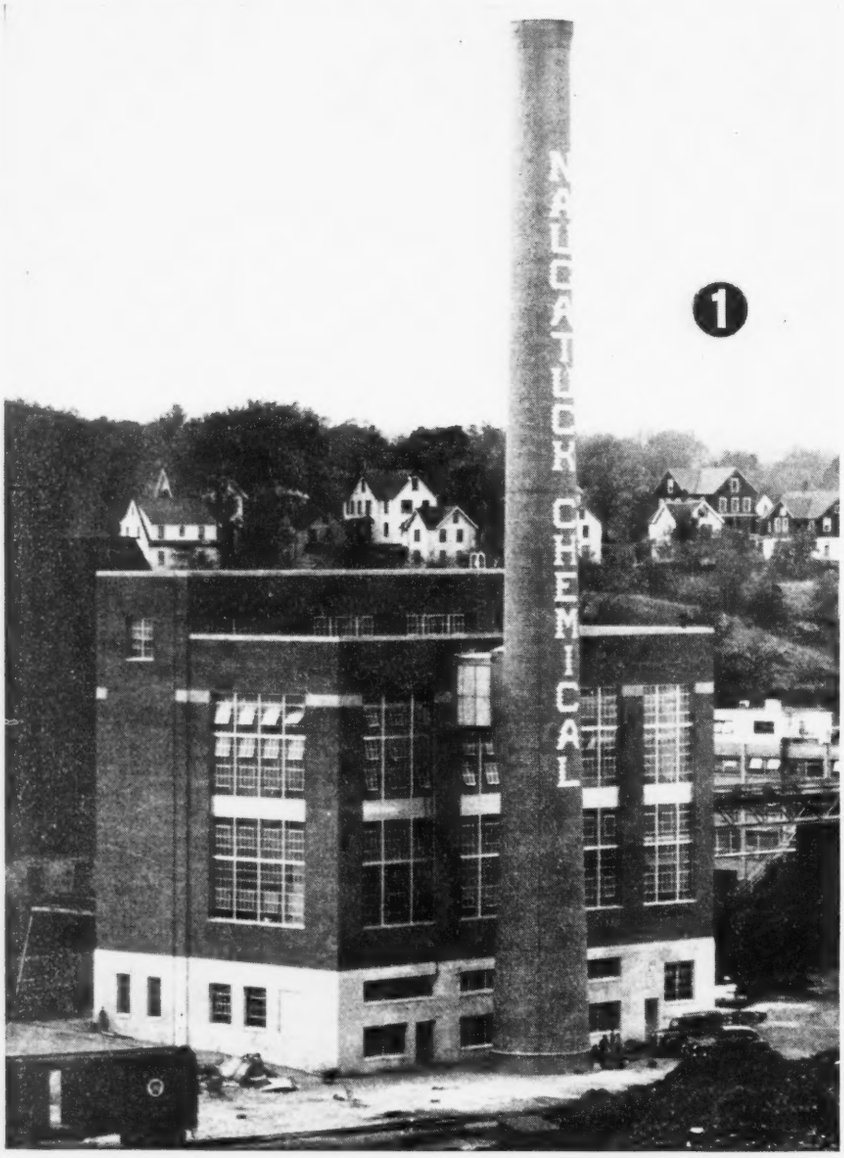
In normal times fire prevention is just plain good business. Now, when every pound of material is precious and the output of every machine tool carries weight in the "battle of production", keeping fire loss down becomes a patriotic duty. With one eye focussed on the possible results of carelessness and the other cocked in the direction of the potential saboteur, an intelligent engineer can make himself worth more than an extra insurance policy.

The formula for action is simple. Expert help is available for the asking. Every community has fire protection. Most every fire department has a fire-prevention squad. Reach for your phone now and call for the local chief. Ask him to send one of his good men over just to look around. You will get more education than you expect.

Investment cost: one cigar or less. Dividends: a safer plant and an easy conscience.

Modern Boiler Plant For Naugatuck Chemical

Told mainly in pictures is this story of fuel saved, increased dependability, larger reserve and more constant pressure through replacement of obsolete boilers by complete new plant



1—BOILER HOUSE—Located above the flood level, new boiler house is 66x90 ft with boilers on the second story about 18 ft above yard level. Stack is 175 ft high, 9 ft 5 in. inside diameter at top

▶ THE NEW PLANT of the Naugatuck Chemical Co (Conn.) replaces an old installation totalling 40,000 sq ft of hand-fired Manning and Bigelow Hornsby boilers. Pressure on the old units was limited to 175 lb (all process) and they could barely carry the load. In addition, there was little opportunity for maintenance. Meanwhile the processes were demanding higher pressure at the very time when it would be necessary to reduce pressure on the old boilers. To take care of all this, to eliminate boiler-room flooding, do away with hand firing and find ample space for efficient layout, it was decided to start from scratch with an entirely new boiler house.

Aims of the new design were simplicity, dependability and overall operating efficiency. Economy in first cost was achieved by arrangement and compactness rather than by any sacrifice of quality or performance.

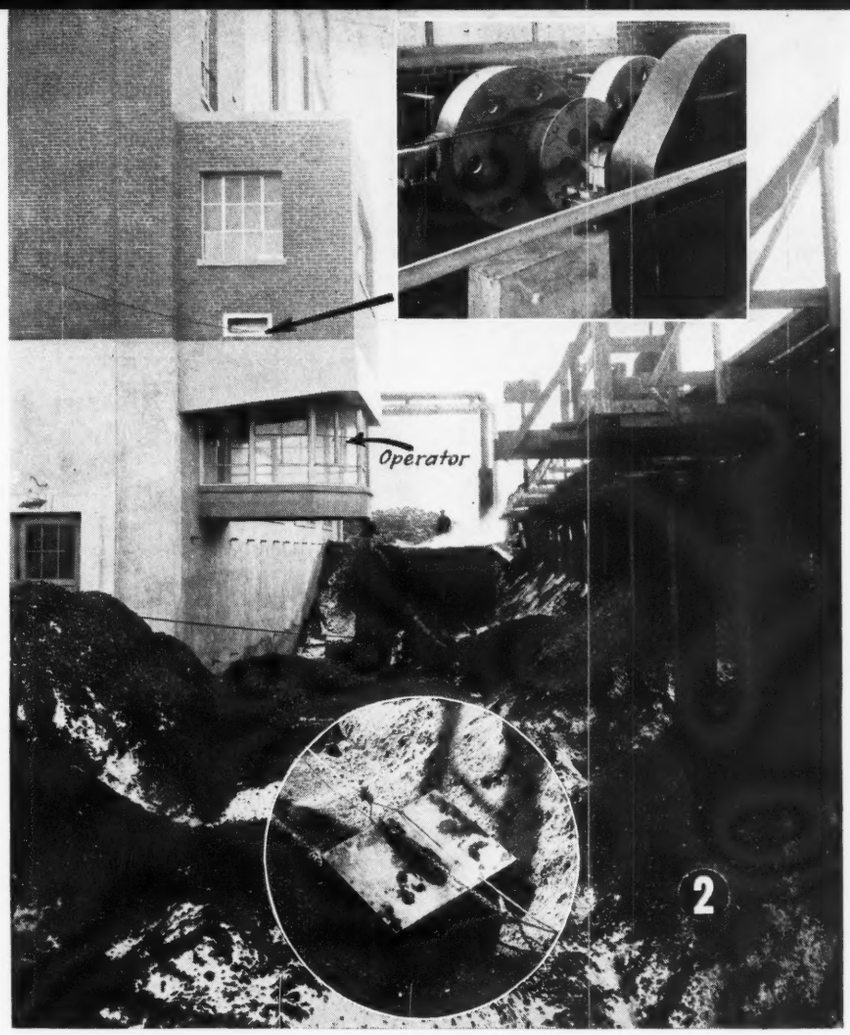
Steam service requirements were difficult. In particular, the processes would allow only a slight variation in header pressure despite numerous small and large load swings. The old plant had to carry load 24 hours per day for five to seven days per week.

The new 3-boiler plant carries the load on two boilers with full automatic control. Instrument charts show instant response of control to steam demand variations, without hunting, and precise maintenance of air-steam ratio at all loads.

Designed for 85.5% top efficiency, the boilers have shown a monthly average of from 81% to 83%.

BOILER AND STOKER PERFORMANCE

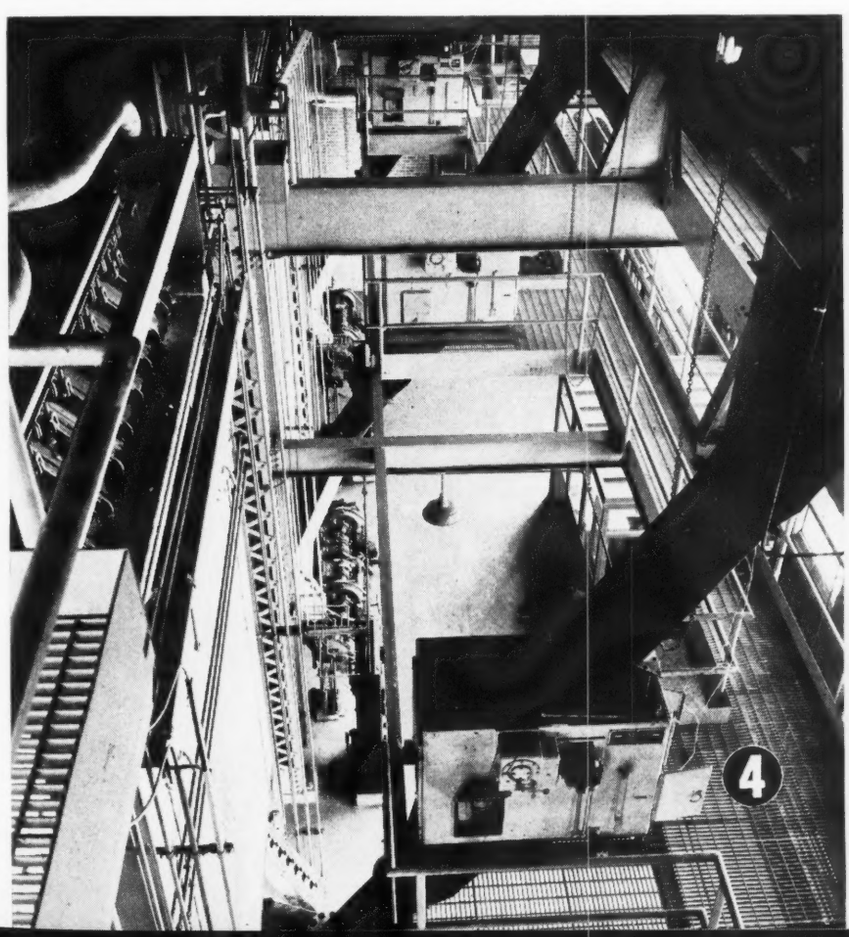
Output Lb per hr	*Coal per sq ft per hr*	*Furnace liberation Btu per cu ft per hr*	*Flue Gas Temp*	*Efficiency %*
30,000.....	18.0	15,700	343	85.44
45,000.....	27.2	23,600	373	85.23
60,000.....	36.9	32,000	415	83.86



2—COAL HANDLING—Received by rail or truck, coal is unloaded to a new track hopper built under the existing trestle. Reserve storage-pocket (foreground) holds 2000 tons. With full vision and weather protection, operator in glass enclosure can distribute and reclaim coal with scraper through hauling mechanism in room overhead

3—CONVEYOR—Normally, coal goes direct from hopper by apron feeder to coal crusher discharging to lower run of Peck carrier, here shown running over top of boiler-house bunker. The bunker holds 350 tons of coal—4- to 6-days supply. A distributing conveyor below the bunker allows coal to be delivered from any part of the bunker to any stoker

4—COAL SCALES—Working down from the bunker level, the coal flows through separate chutes and scales to the three boilers



5—ASH HOPPER—Cars carry ash to the Peck carrier, which elevates it to an overhead bunker (coal bunker extension). Thence it is discharged by gravity to trucks. Advantages of coal and ash handling system include: (1) dependability; (2) low maintenance; (3) freedom from fires; (4) detailed coal-consumption records; (5) dust-tight construction; (6) low operating labor

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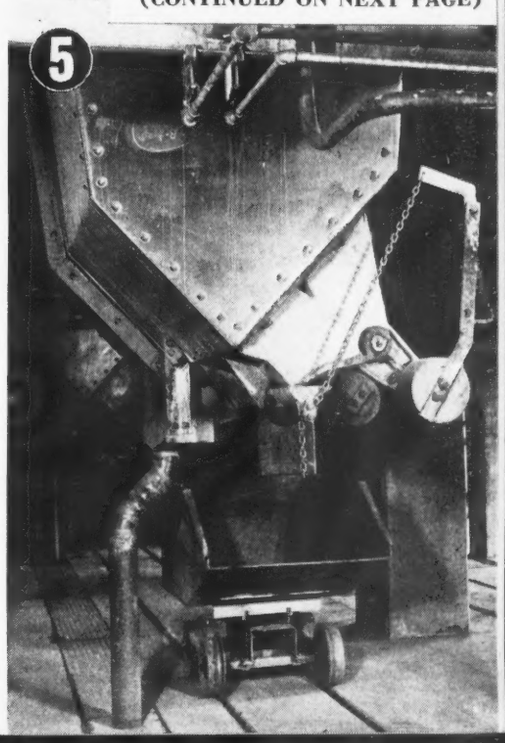
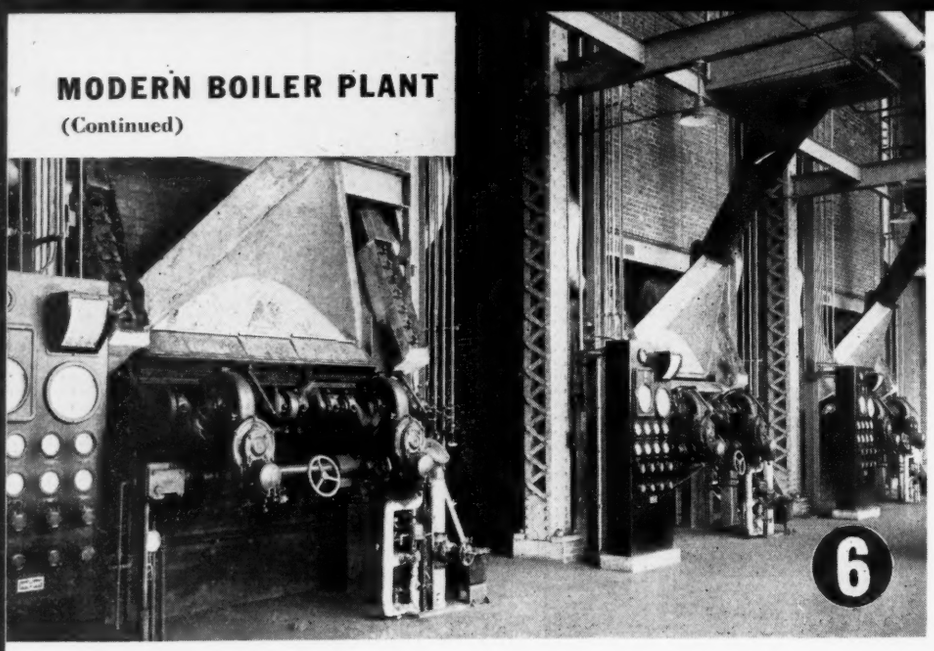
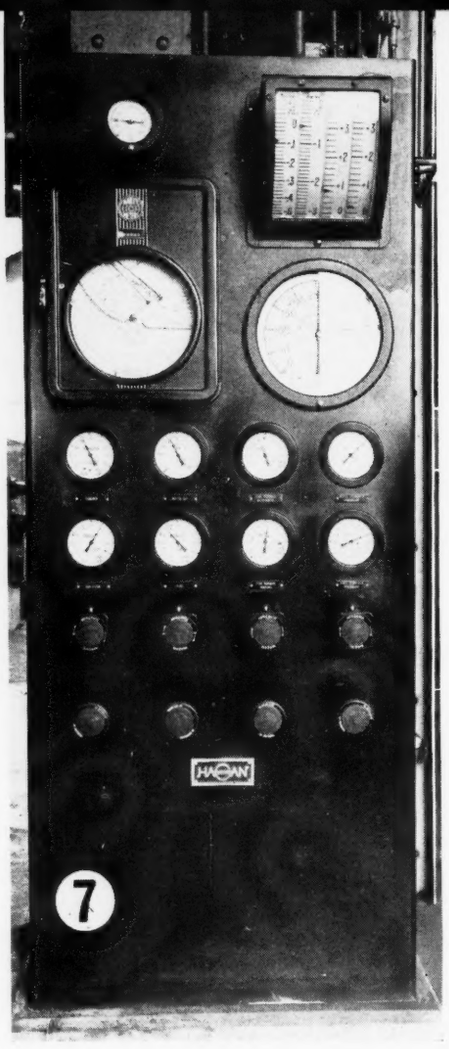


MODERN BOILER PLANT

(Continued)

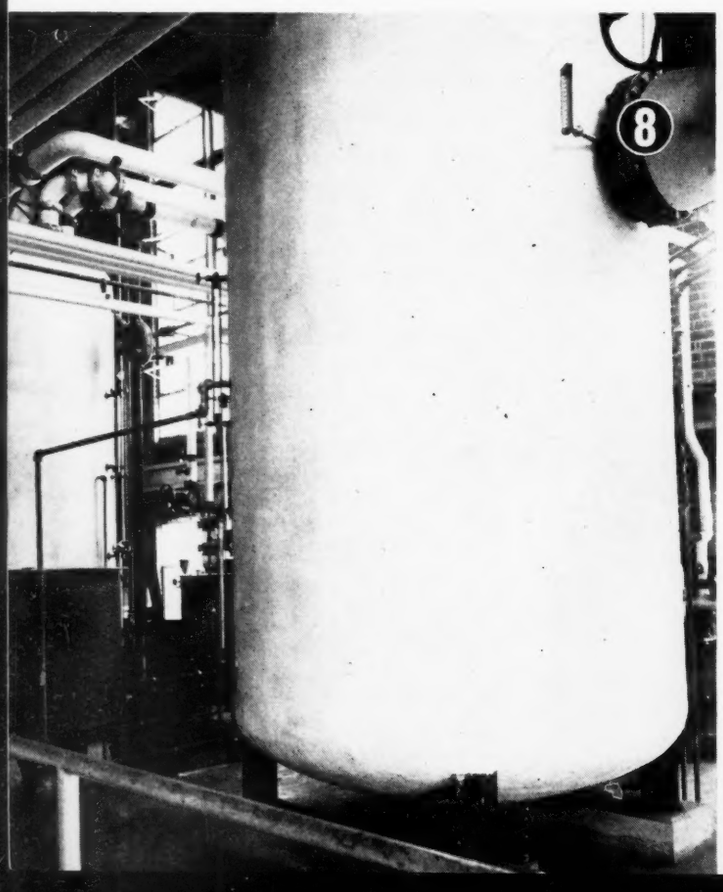


6—BOILERS AND STOKERS—Coal flows through to the three 5-retort turbine-driven underfeed stokers. Fuel is West Virginia slack, 13,500-14,200 Btu per lb. The three boilers are bent-tube, 4-drum, Stirling units with brick settings and water-cooled bridge and sidewalls. Normal capacity each is 60,000 lb of 260-lb saturated steam per hour. Ordinarily two boilers will carry the load (82,000 lb per hr average, 120,000 lb max.). Each unit has an air heater, economizer, forced and induced-draft fan. Both fans are turbine driven through a single shaft

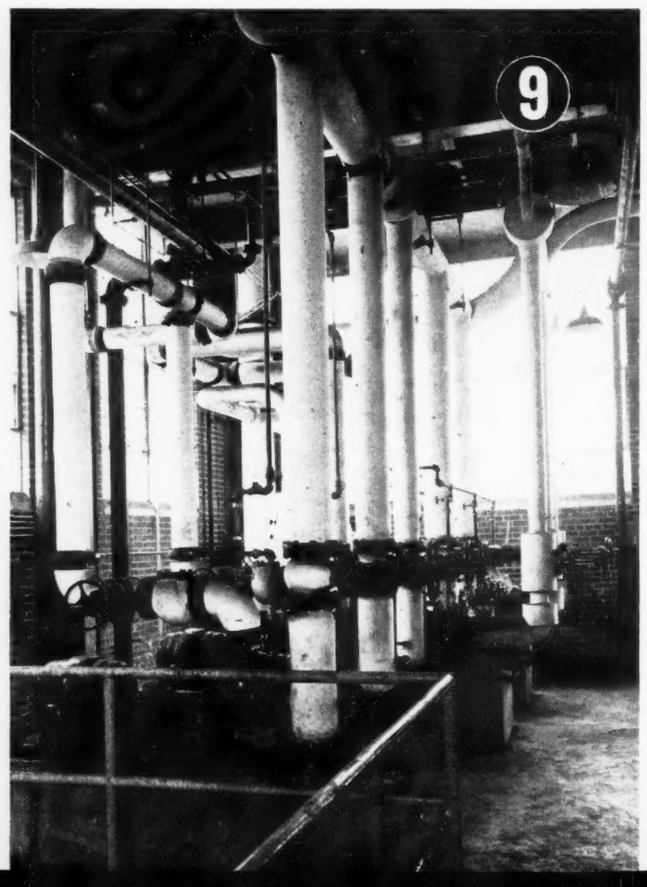


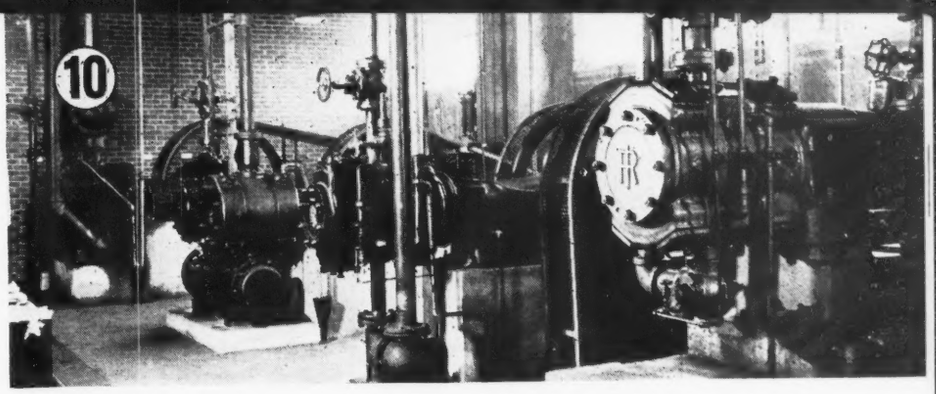
7—CONTROL BOARD—On each control board are mounted: Bailey meter showing steam flow, air flow and flue-gas temp.; gage showing pressure in windbox, furnace and last pass; gages showing steam, air and control pressure and fan speed; combustion-control regulator. Hagan control system regulates fan and stoker speeds from steam pressure. Furnace-draft controller operates uptake and forced-draft dampers. A Venturi meter measures feed water. Steam meters record output to plants 1 and 2. Indicating instruments show steam pressure and steam and water temperature

8—FEED HEATING—Pumps in the original plant deliver condensate from the old feed heater to an elevated surge tank. This tank also receives returns from the condensate pump in boiler house and city water or service water makeup. Relay pumps deliver feedwater from this surge tank to the new deaerating heater where it is heated to 240 F by auxiliary exhaust

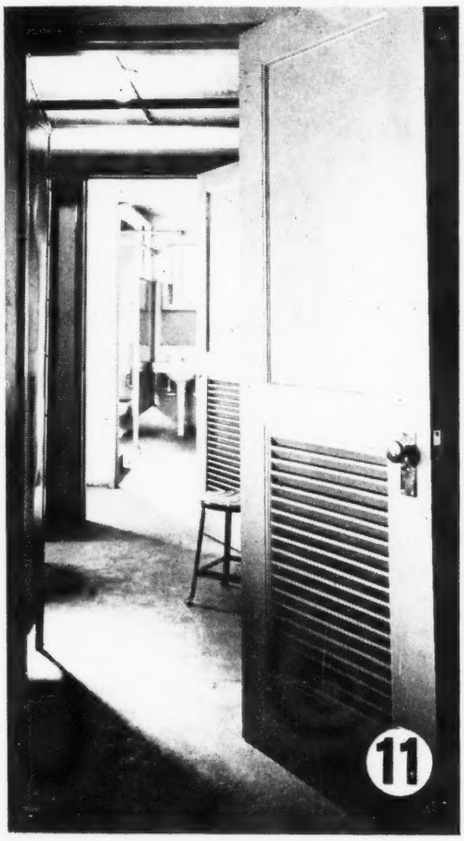


9—FEED PUMPS—The three boiler feed pumps are centrifugal: one 300 gpm and one 100 gpm motor-driven and one 300 gpm turbine-driven. The feedwater is treated in the boilers by piping a chemical solution to the mud drum. A continuous-blowdown line leads from a collecting pipe in the upper front drum of each boiler through throttling valves to a flash tank





10—COMPRESSORS—Four air compressors (3 motor driven and one steam driven) have been relocated in the new boiler house. Inlet air is filtered. Air discharge at 70 to 90 lb is piped to a tank supplying the boiler controls, instruments, etc. and over the bridge to the manufacturing plants



11—LOCKERS—Stressing the importance of proper sanitary facilities, the designers have provided a double locker room with shower between to permit complete segregation of clean clothes and work clothes. Coming to work, the worker undresses in the street locker room and leaves his clothes there, then passes to the plant locker room for his work clothes. On leaving, he reverses the process, taking a shower on the way to the street locker room

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Consulting Engineers

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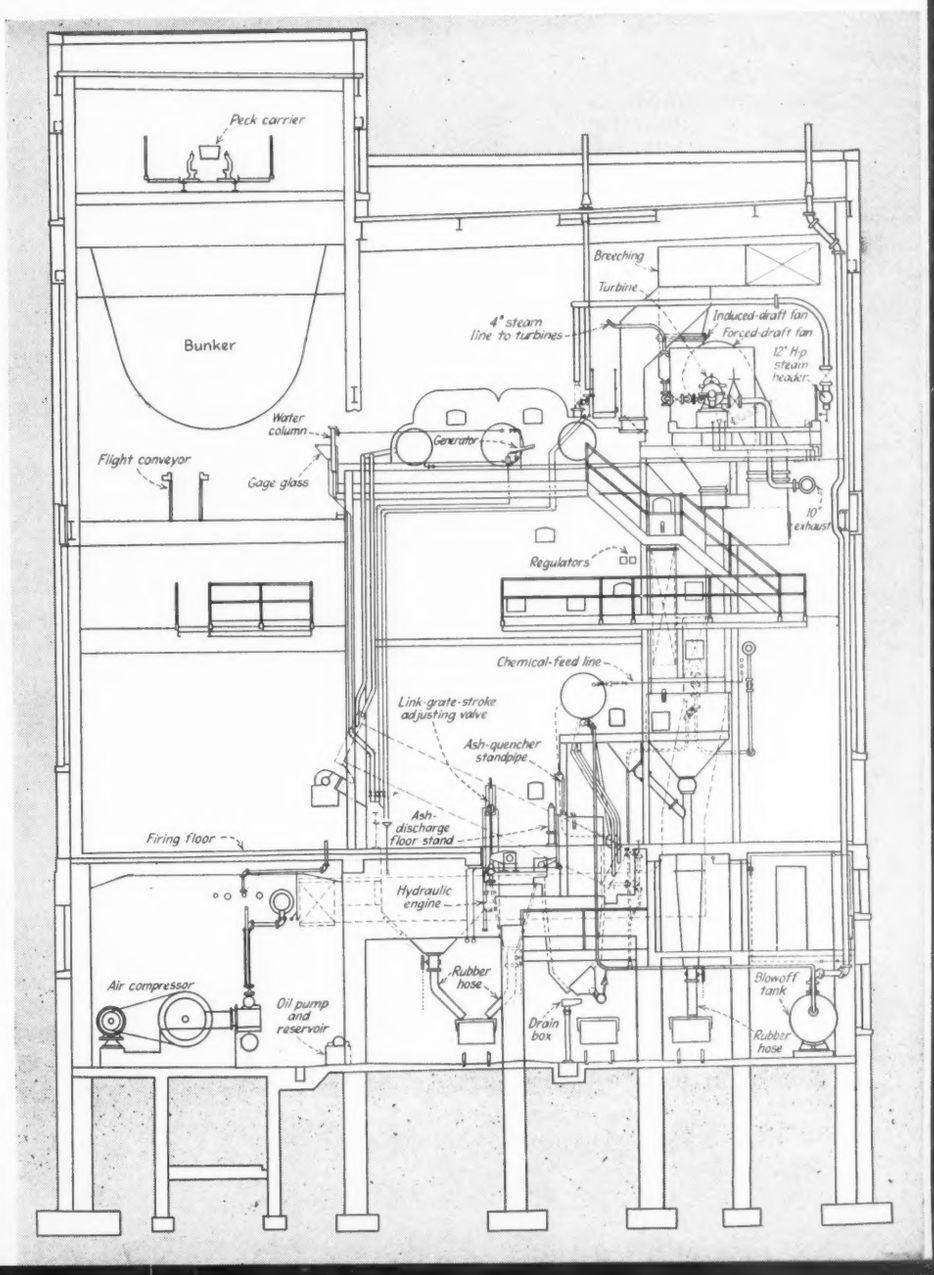
Stokers	Westinghouse Elec & Mfg Co
Stack	M W Kellogg Co
Settings	Geo Allen & Son
Conveyors	Link-Belt Co
Feedwater heater	Elliott Co
Boiler feed pumps	Allis-Chalmers Mfg Co
Building	W J Megin Inc
Elevator	Eastern Machine Co
Soot hoppers	Beaumont Birch Co
Controls	Hagan Corp
Relay pumps	Allis-Chalmers Mfg Co
Switchboard	Westinghouse Elec & Mfg Co
Piping	Holyoke Valve & Hydrant Co
Electric Wiring	M B Foster Elec Co



CROSS SECTION—Three 60,000 lb-per-hr boilers are fired by 5-retort underfeed stokers and equipped with air heaters, economizers and forced- and induced-draft fans. Normally two boilers will carry the maximum load

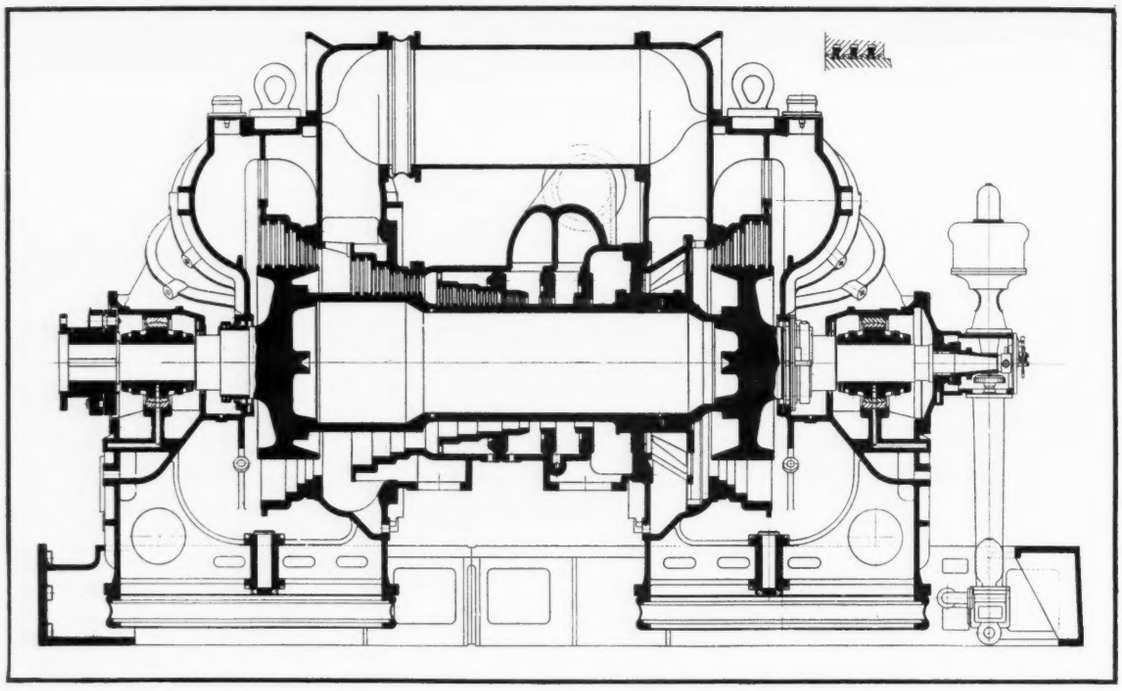


Fig. 1—Longitudinal section of 185-lb straight-reaction turbine as originally put in service in Gold St Station in 1917. Unit was rated 30,000 kw at 1500 rpm

More Kw From Old Turbines

A new rotor and blading make 40,000 kw of 60-cycle power in the same frame that used to turn out only 30,000 kw of 25-cycle. How Gold St and Sherman Creek units were given a new lease on life is told by E Zetterquist of Westinghouse

▶ As 60-CYCLE LOAD in Brooklyn, N. Y. grew, and the 25-cycle load gradually decreased, older generating units in Gold St Station were used less and less. To make one of the station's four units directly available as a spare for Hudson Avenue, and possibly also for future service with a topping turbine, Westinghouse rebuilt a 30,000-kw, straight-reaction, 185-lb, 100-F-superheat, 25-cycle machine for 60-cycle operation.

Specifications called for a maximum capacity of 40,000 kw at 1800 rpm at the original throttle conditions, but with vacuum reduced from 28.5 to 26-in. to insure full capacity with existing condensers during summer operation. Revamping was carried out without modifications to foundations and piping other than those necessitated by adding a direct-connected exciter and changes to the lubricating system.

A comparison of Fig. 1, the original turbine, with the rebuilt machine of Fig. 2, shows the extent of the modifications. The new spindle, completely assembled and bladed, weighs 105,000 lb. Shrunk-on disks are chrome-nickel-molybdenum steel, the main-spindle body is carbon steel. The latter measures 22 ft, 2 in. between bearing centers and is probably the longest of its kind ever put in operation. The radical change in bearing size because of critical-speed requirements is evident from the drawings. Original 13.5 x 27 in. bearings were replaced by 19 x 19.

In redesigning the machine, we found it necessary to adopt a 2-step balancing piston to secure proper loadings on the thrust bearing. Leakoff is through radially drilled holes to the central inspection bore, which is 10 in. in diameter and runs the entire length of the main spindle. To prevent heat flow to the bearings and reduce such flow to the low-pressure disks, steam-tight plugs carried on steel tubing were inserted from each spindle-end deep into the inspection bore.

In this design, leakage through the high-pressure section of the balancing piston remains nearly constant with increase in load from full primary-valve opening to maximum output. Flow through the low-pressure section, on the other hand, increases directly with load. To prevent leakage past the low-pressure section from becoming greater than that past the high-pressure section, and thus to eliminate reversal of flow through the spindle that might cause variation in balancing-piston temperature, most of the sealing strips were allotted to the low-pressure section, see Fig. 2.

The rebuilt machine contains 16,800 blades, arranged in 31 pairs of rows. All, except the last two rows at each end, are shrouded against double radial

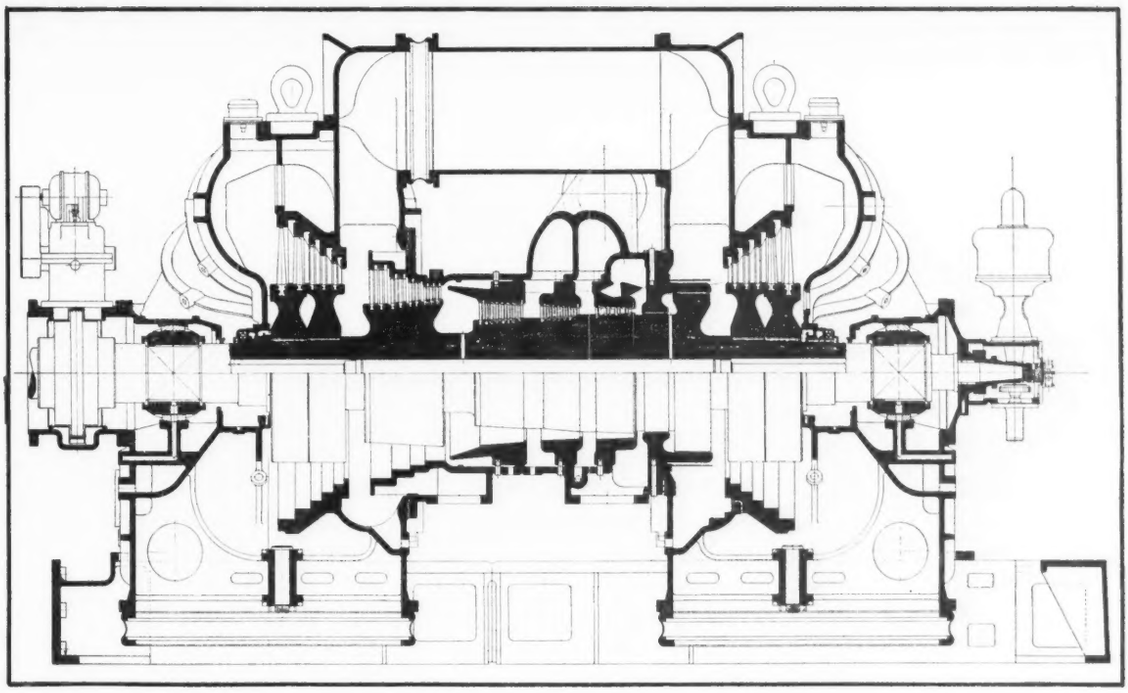


Fig. 2—Rebuilt turbine illustrates advancement in turbine construction over the past two decades. New spindle is 22 ft, 2 in. between bearings and turns out 40,000 kw at 1800 rpm

seals, Fig. 3. The last stationary row at each end is cast bronze, all others are chromium steel. The spouting area of the exhaust blades has been increased by 60% and tip speed by nearly 25%.

Re-use of the center section of steel cylinder necessitated adherence to the barrel-type design for the outer section of the last single-flow blade group. Because of erosion of the walls and the wider blades, this part of the cylinder was rebored and regrooved for special notched blade-roots with side caulking wedges.

The support of the dummy ring, as well as of the three central blade rings, was modified in line with latest practice. Original clamp rings, making the dummy and blade rings in effect part of the cylinder structure, were eliminated and the clamping lands remachined for circumferential, stainless-steel sealing strips matching similar strips in the rings, as illustrated in Fig. 3. The rings are supported on lugs at the horizontal joint and held central by pins or keys at top and bottom centers. They are thus free to expand independently of the cylinder and are always maintained in a central position.

Moisture Protection

Steam in the receiver pipe, where the flow divides into the two low-pressure exhaust groups, is in the wet region. To prevent warping of the low-pressure section of the dummy ring from water carried over, an outer steel jacket or apron was provided around both upper and lower halves of the dummy ring resulting in more equal expansion.

To maintain closer lateral alignment than possible with existing cylinder side-supporting pedestals, heavy steel bars were thrown across the bedplate at each end and doweled in place after having been fitted to existing vertical central reinforcing ribs in the cylinder base. These cross bars are shown in Fig. 2.

The original supporting members at the inlet to the low-pressure blading at each end were eliminated, since they no longer served a useful purpose and obstructed steam flow.

Other modifications included the substitution of a solid coupling with turning gear for the old pin-type flexible coupling, putting in new glands and eliminating the gear-driven main oil pump under the governor. This pump was replaced by a motor-driven gear pump backed up automatically by a duplicate turbine-driven pump, as well as by the existing engine-driven auxiliary oil pump. The motor-driven unit also supplies the bearings while the machine is on turning gear.

The change in speed and frequency necessitated a completely new generator stator built into a skeleton frame suited for insertion in the old cast-iron

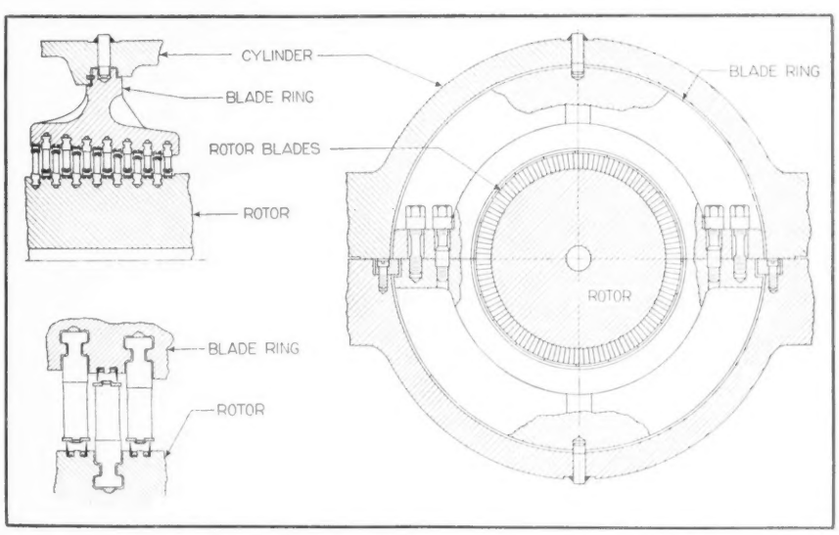


Fig. 3—New blade rings pinned within the old casing carry blading and seals as modern as any new units

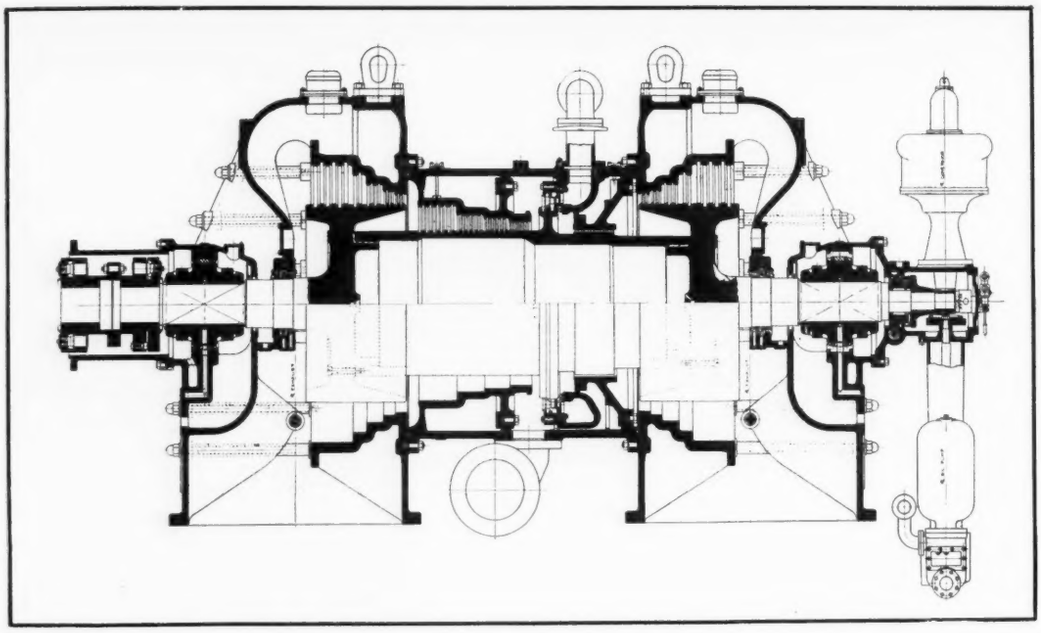


Fig. 4—In 1916 this 20,000-kw 25-cycle unit at Sherman Creek Station had a 12.8 lb per kwhr steam rate. Since rebuilding to 30,000 kw, 60 cycles, (Fig. 5) it requires 8% less steam at the same temperature and pressure

frame, after removal of coils and iron. The new 4-pole rotor was fitted to existing pedestals and bearings. A 180-kw direct-connected exciter, with a 3-kw pilot exciter, was added.

The revamped Gold St unit was put on the line in February, 1941. Its service for the present is expected to be of a peak-load nature and it is supplied with reduced-pressure, desuperheated 400-lb steam from nearby Hudson Avenue Station, through a tie line connecting the two plants.

Prior to rebuilding the Gold St machine, two 20,000-kw, 1.0-pf, 25-cycle machines at Sherman Creek Station were similarly reconditioned. These machines were re-rated to 30,000 kw at 0.85 pf and 60 cycles for the same throttle conditions as at Gold St. Fig. 4 shows the original design of these units and Fig. 5 the present design.

The hollow central-drum section, serving as receiver pipe for steam to the governor-side exhaust blading, is nickel steel, while the spindle ends are chrome-nickel-molybdenum steel. The joints are made up with heavy shrink fits. As at Gold St, a solid coupling with turning gear was substituted for the pin-type coupling.

For the latter machines, capacity increase required replacement of exhaust cylinders to provide space for larger exhaust blading. Tip speed of the last spindle rows was increased 50% and the spouting area from 1340 to 3180 sq in. per side, nearly 2½ times. Consequent reduction in leaving losses, together with reduced blade and leakage losses, gave a tested steam rate of 11.7 lb per kwhr at 30,000 kw, 29-in. vacuum. Tests conducted in 1916, after the original units were first placed in service, showed a full-load steam rate of 12.77 lb. Reconditioning improved efficiency by more than 8%, and increased capacity over 50%.

These two units at Sherman Creek are part of the low-pressure capacity that will operate with steam exhausted from a 50,000-kw, 1600-lb, 950-F element. Condensers, pumps and foundations for two more or less obsolete and inactive units thus have formed a basis for a load structure of about 95,000 kw, nearly 2½ times original capacity.

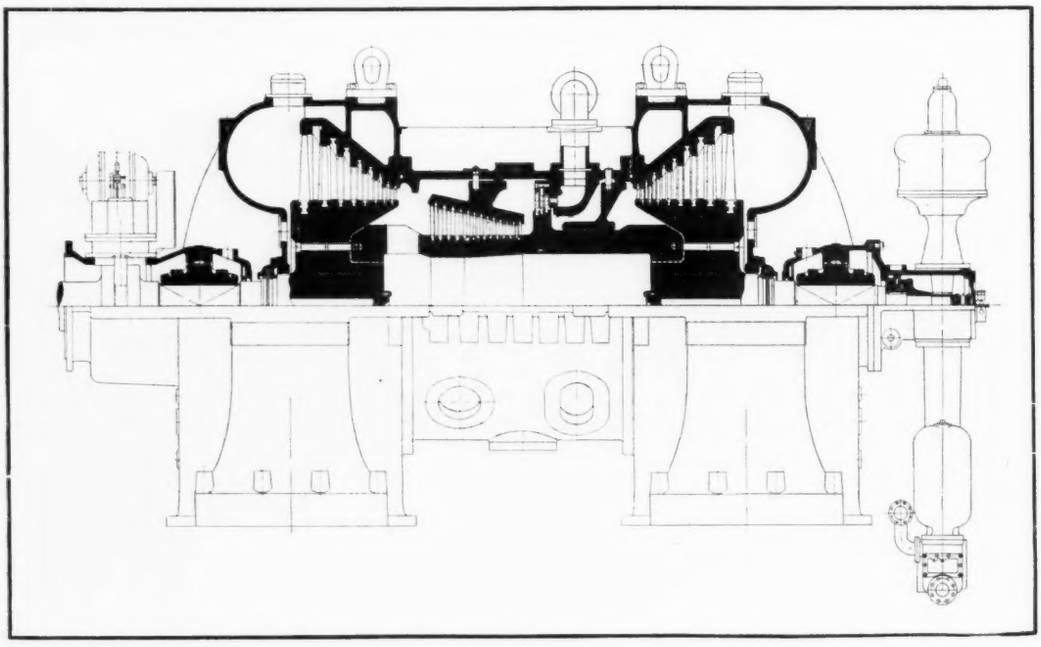


Fig. 5—Two of these rebuilt machines are ready for the exhaust from Sherman Creek's new 50,000-kw 1600-lb high-pressure top scheduled for 1942

Capacitors for Power-Factor Improvement—I

M I Alimansky, capacitor engineer, General Electric Co, shows how to use capacitors to increase power-generating and distributing-equipment capacity, to reduce power losses and cost, and to better voltage conditions by improving power factor

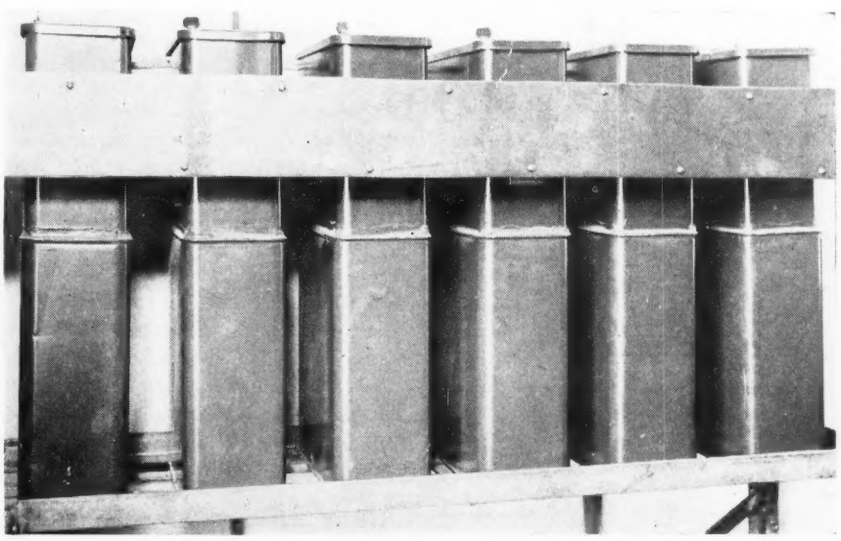


Fig. 1—Six dust-tight 15-kva, 406-volt capacitor units installed on a 3-phase, 60-cycle power-distribution system

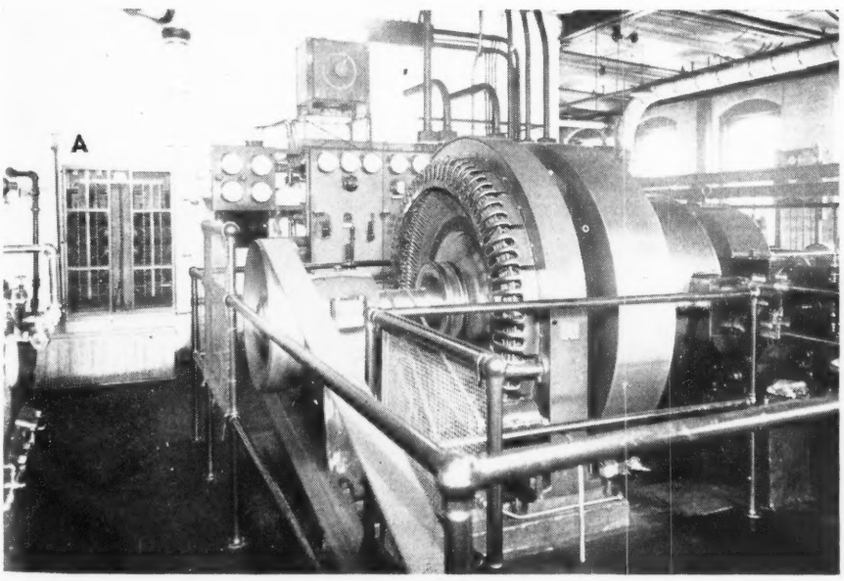


Fig. 2—Rack-type, 50-kva, 230-volt capacitor (*A*), for indoor service, improves power factor of an isolated paper-mill power plant

▶ TODAY, POWER DEMANDS in industrial plants are reaching new highs. Many plants, in attempting to increase production, are adding electrical loads to power-supply facilities that are inadequate. They are caught with insufficient generating capacity, wiring capacity, transformer capacity or switching capacity. In some cases these facilities are not only fully loaded but overloaded. Frequently it is possible to obtain a substantial margin of capacity out of existing facilities, either for additional loading or for relieving an overload condition, by improving the power factor on the electrical circuits.

Power-Factor Defined

Power factor may be defined as the ratio of kilowatts (wattmeter reading) to kilovolt-amperes (calculated from the voltmeter and ammeter readings). In other words power factor (pf) = kilowatts (kw) ÷ kilovolt-amperes (kva). As an example, assume a balanced 3-phase circuit in which the wattmeter reads 45 kw, the voltmeter 440 volts and the ammeter 75 amp. Kilovolt — amperes = volts × amperes × 1.732 ÷ 1000 = 440 × 75 × 1.732 ÷ 1000 = 57 kva. Power factor = kw ÷ kva = 45 ÷ 57 = 0.80.

Power factor of a system depends upon the character of the loads. If the load consists largely of transformers, electromagnets and induction motors that require magnetizing current, then the power factor may be as low as 0.60 lagging, or less, particularly if the motors are only partly loaded. On the other hand, when a considerable percentage of the load consists of resistance devices and synchronous motors, the power factor may be nearly 1.00 (unity) or leading, which is the ideal condition.

Low-lagging-power-factor loads are objectionable for several reasons: First, generators, transformers and power lines must be larger to supply a given kilowatt load. For example, approximately 33% more generator, transformer and line capacity are required to supply a given kw load at a power factor of 0.75 than at unity power

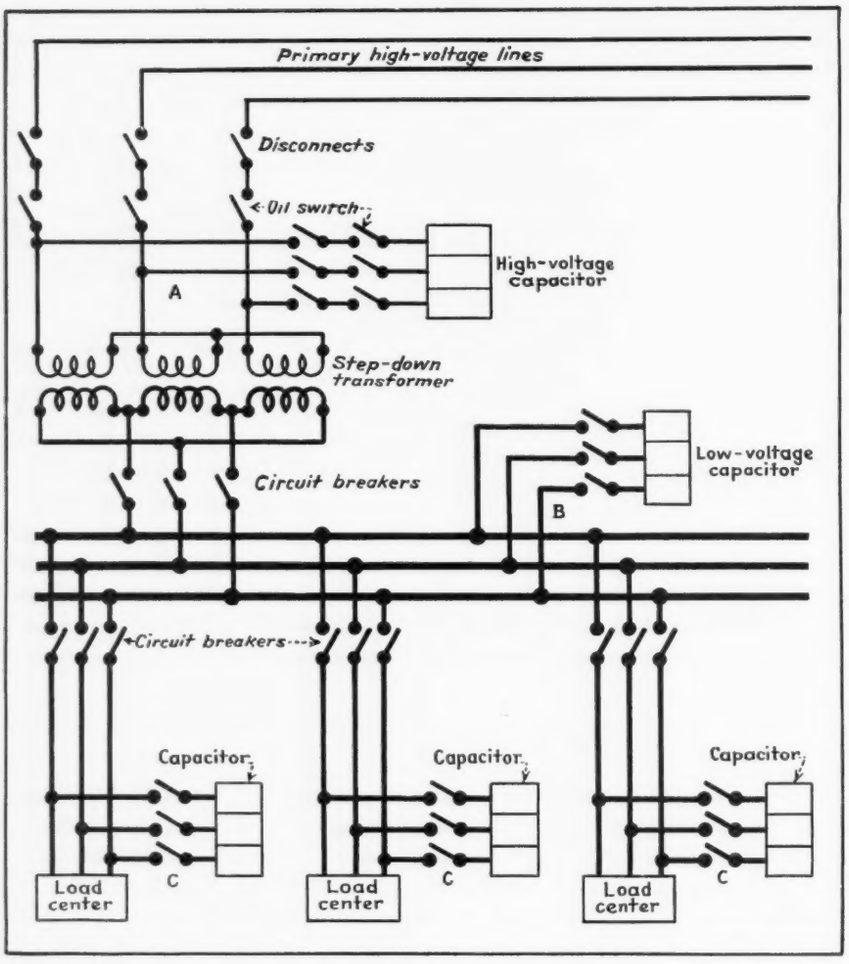


Fig. 3—Capacitors may be installed on the high-voltage line, on the low-voltage bus, or on the distribution lines at the load centers

factor, assuming the same voltage in both cases.

Second, low power factor increases power losses in generators, transformers and lines. These losses are approximately 75% greater at a 75% power factor than at unity. Voltage-regulation is impaired by low power factor, which may cause poor operation of equipment on the line. Low voltage may reduce motor speed and decrease driven-machine output.

Purchased Power

When power is purchased, rates are frequently increased if the load power factor is less than a given value and decreased if above that value. For these reasons, in addition to relieving overloads, it is frequently desirable to improve the power factor if it is below 0.80 or 0.85. Frequently, improving the power factor will increase plant efficiency when power is generated, or reduce the power cost, when power is purchased, sufficiently to pay the cost of the corrective equipment in a year or two.

A common way of improving power factor is with capacitors. These units are large static condensers built to withstand the conditions encountered on industrial power circuits. They are rated in kilovolt-amperes, like generators and transformers. For 230 volts, individual units have a rating of 7.5 kva, and for 460 to 13,800 volts the

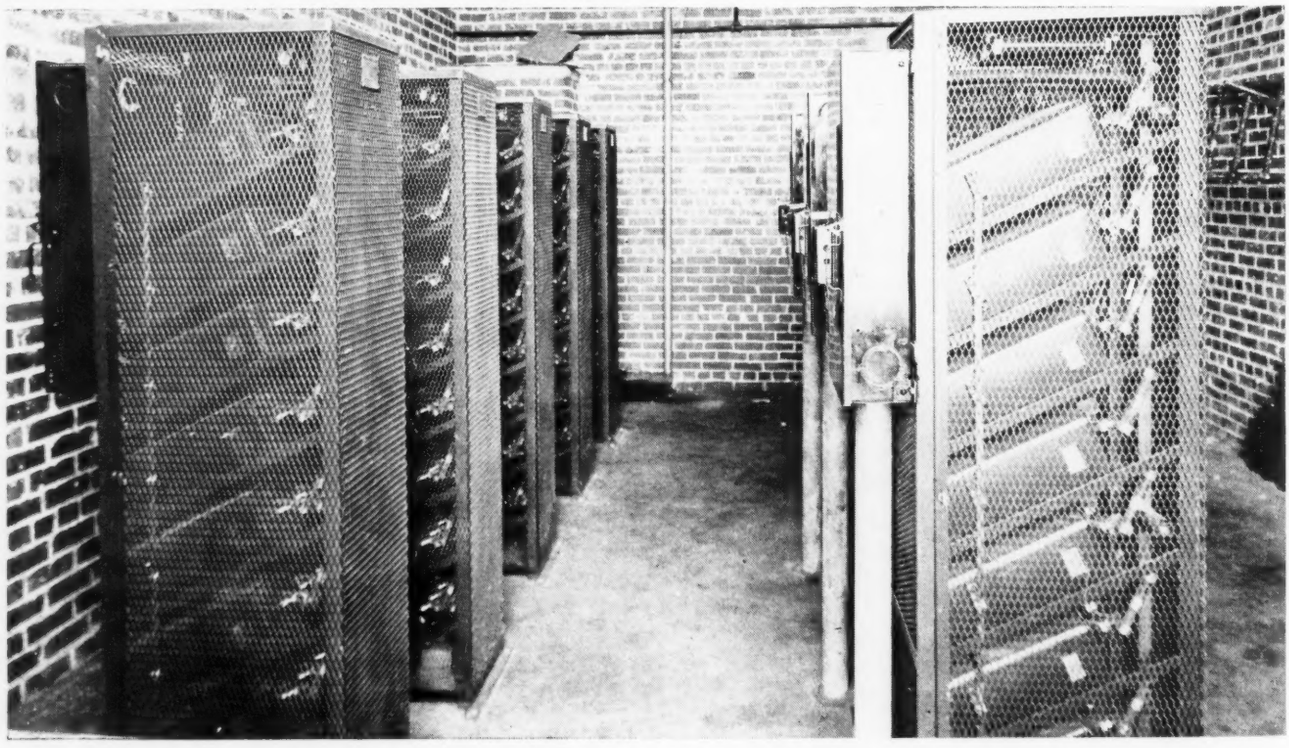


Fig. 4—A 960-kva capacitor installation consisting of eight 120-kva, 460-volt units installed in a large textile mill

units are rated 15 kva. Capacitors of higher rating are obtained by connecting these units in parallel.

Capacitor installations usually consist of the required number of units assembled in a hanger, rack or weatherproof housing. These units also have a switching device that serves to connect and disconnect them from the line, serving as a circuit-interrupting device in case of a fault.

Except for small individual-unit capacitors applied at motor terminals, all capacitors for industrial plants should be equipped with individual indicating-type unit fuses. Experience indicates that this is desirable, because it facilitates inspection of equipment. Of course, in locations such as textile and grain mills where inflammable dust or lint is encountered, the fuses must be enclosed in dust-tight compartments. Dust-tight capacitors are shown in Figs. 1, 5 and 6.

Capacitors, when disconnected, retain a charge which is evidenced by a voltage corresponding to the crest value of circuit voltage. All equipment, large and small, should be provided with a discharger which will discharge to 50 volts or less in one minute. This is a National Electrical Code requirement.

Switching Equipment

Switching equipment may be selected in many forms. For low-voltage, enclosed, fused safety switches have proved satisfactory and have the advantage of low cost. Small air circuit breakers are also excellent and possess some advantages over the fused switch in operation and maintenance. Their first cost is generally higher. In the low-voltage classes, large air circuit-breakers have been used extensively for group capacitors of high kva rating. On equipment for 2400 volts and above, fuse cutouts and oil circuit breakers are used. The cutouts are satisfactory for smaller kva ratings, but their application is limited to 120 kva (3-phase) and less, since, as switches, their current interrupting ability is limited because their contacts open in air. Specific recommendations should be obtained from the manufacturer.

Larger equipment up to and including 180 kva can be provided with oil-fuse cutouts which will switch up to 100% of their rating. Above 180 kva, circuit breakers are necessary.

In the selection of any switching device, attention must be paid not only to its normal current-carrying ability but to its short-circuit interrupting capacity. The short-circuit current available at the capacitor installation point should be checked and the switch

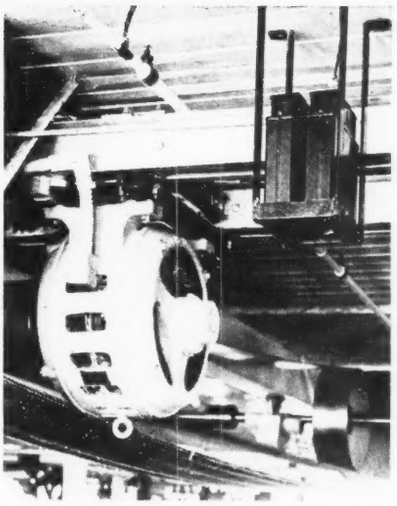


Fig. 5—A 20-kva, 575-volt capacitor, consisting of two 10-kva units, improves power factor of a large induction motor

selected with that fact in mind.

When using capacitors to improve power factor, they may be connected on the high-voltage bus as at *A*, on the secondary bus, as at *B*, or spread out on the secondary circuits, as at *C*, Fig. 3. By placing the capacitors close to the load, not only is power factor improved on the entire system, but power losses are reduced in distribution lines, feeders, transformers and generators. Voltage regulation is also improved on the entire system.

If the capacitors are located on the high-voltage line the power factor will be improved and load on the transmission line and power plant reduced, but the step-down transformers and the distribution system will not be benefited. If metering equipment is connected on the low-voltage side of the transformer, then the capacitors have to be connected somewhere on the low-voltage circuit to register the power-factor improvement.

Application Point

The optimum point of application of capacitors must be determined by individual study. The criterion is purely an economic one. 460- and 575-volt capacitors generally cost a little more than 2400- or 4160-volt units. Capacitors for 4800 volts and higher are more expensive than those for 2400 and 4160 volts. Thus 460- and 575-volt capacitors will generally work out more favorably if the primary is 4800 volts. On secondaries rated 230 volts, the higher cost per kva of the latter will sometimes throw the balance in favor of primary units. But even here, other considerations often over-rule.

Some of these conditions may be an overloaded transformer bank, over-

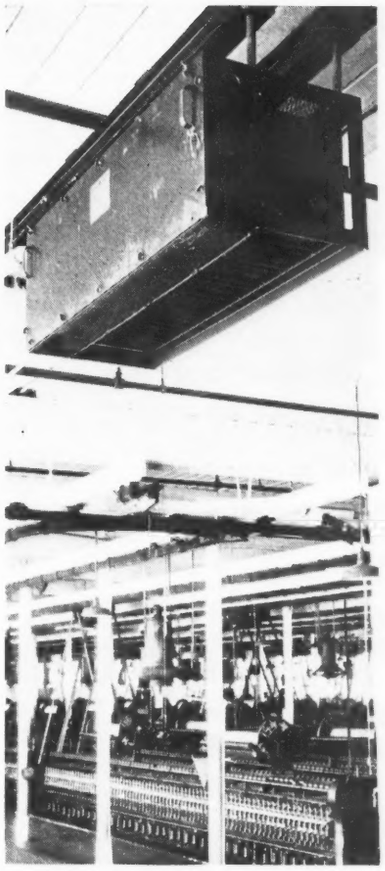


Fig. 6—Rack-type, 120-kva, 575-volt dust-tight capacitor equipment mounted on ceiling of spinning room and connected to power feeders supplying driving motors

loaded feeders, etc. By applying secondary capacitors, these components of the circuit will be relieved and a major investment in new equipment made entirely unnecessary, or postponed for an appreciable time.

Voltage improvement must not be neglected. Current reduction not only reduces losses but improves voltage as well, and this means better operation of lamps and motors—a factor hard to evaluate in dollars and cents, but tangible nevertheless.

Capacitors play a vital part in improving plant efficiency and reducing power costs. Their application is a relatively simple matter, once a few fundamentals are grasped. Design-improvements and research have not only brought the capacitor to a high degree of reliability but have also reduced unit size and weight. To a major degree these benefits have been the result of the development of a non-inflammable liquid with extraordinary dielectric qualities. A later article will tell how to calculate the correct size of capacitors for a given power-factor-improvement job and give results of some installations.

Model Test Checks Pipe-Stress Calculation

Simplified calculation method can be applied to 3-dimensional pipe lines of variable size or with corrugated sections. Actual case calculations, presented here to illustrate method, agree closely with model test

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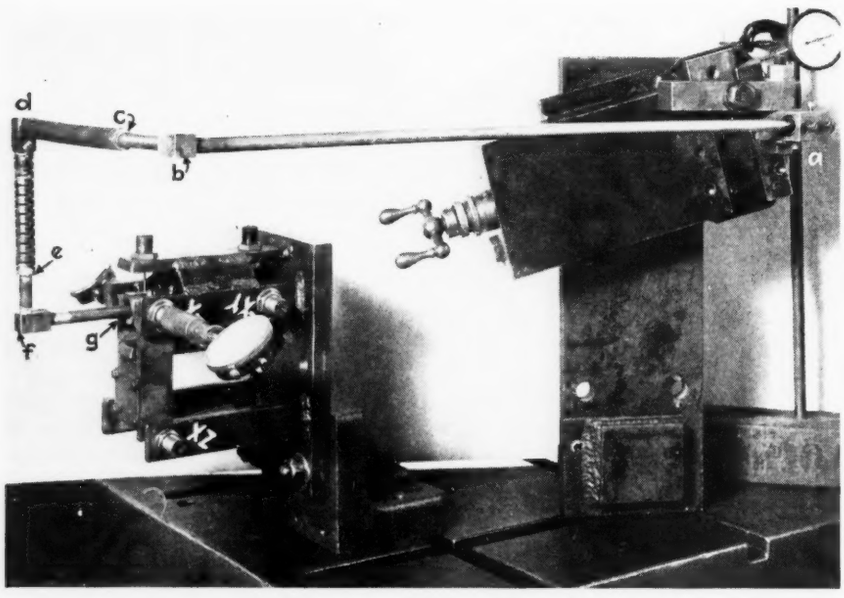


Fig. 1—Model test by Westinghouse of end reactions of turbine-exhaust header for new Sherman Creek unit checks calculations. Note slotted tubes to simulate corrugated pipe. Letters correspond to numerical computations on opposite page

▶ FOR HIGH-TEMPERATURE steam lines of different pipe-size, or containing sections of corrugated piping, certain changes are required in previously explained (POWER, Jan. and Feb. 1941) end-reaction calculations. The fundamental formulas:

$$+XI_x - YI_{xy} - ZI_{xz} = \Delta xEI$$
$$-XI_{xy} + YI_y - ZI_{yz} = \Delta yEI$$
$$-XI_{xz} - YI_{yz} + ZI_z = \Delta zEI$$

have the moment of inertia I of pipe cross-section at the right-hand side of the equations. It actually belongs to each individual branch, that is, the coefficients I_x, I_y, I_{xy} should be divided by I. However, for a line with constant cross-section, I can be brought to the right-hand side, considerably reducing numerical computation.

For pipe lines with branches of different cross section or flexural rigidity, the equations take the following form:

$$+X\frac{I_x}{I} - Y\frac{I_{xy}}{I} - Z\frac{I_{xz}}{I} = \Delta xE$$

$$-X\frac{I_{xy}}{I} + Y\frac{I_y}{I} - Z\frac{I_{yz}}{I} = \Delta yE$$

$$-X\frac{I_{xz}}{I} - Y\frac{I_{yz}}{I} + Z\frac{I_z}{I} = \Delta zE$$

In this setup the meaning of $\frac{I_x}{I}$ for instance, is the moment of inertia of each branch about axis x, divided by the moment of inertia I, of its own cross-sectional area. Since calculating moments of inertia of pipe length involves squaring and cubing lengths and distances, precaution must be taken, in introducing numerical values of area inertias, that I is carried along in the first power and not accidently included in the process of squaring or cubing. The setup of calculations on the opposite page, for which the numerical values apply to an actual case, follows a definite pattern designed to eliminate errors of this kind.

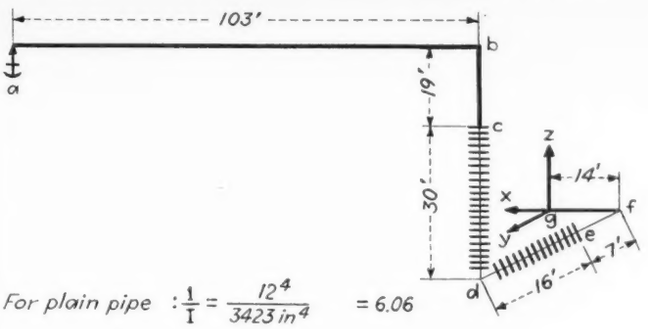
In the numerical example selected, a 24-in. pipe-run contains two branches of 24-in. corrugated pipe. In bending, flexibility of corrugated pipe has been established by test as five times that of plain pipe. In torsion, its flexibility equals that of plain pipe.

Moment of Inertia

With the moment of inertia of 3423 in.^{4} for the plain pipe, the effect of the corrugated branches is expressed by using one-fifth of this value in projections which show the corrugated pipe in bending (branch appears in true length) and the full value of 3423 in.^{4} projection which indicate the corrugated branch in torsion (solid dot). Keeping in mind that length is expressed in feet and moment of inertia in inches to the fourth power, each plain branch is multiplied by 12^4, divided by 3423 or 6.06, and each corrugated length, when engaged in bending, by five times this figure or 30.3.

When the lengths are to be squared or cubed, which happens in calculating the values of I_x, I_y and I_z, the multipliers (in this case 6.06 and 30.3) are placed outside a parenthesis to avoid their being squared or cubed. As example, refer to I_x for branches *de* and *ef* in *xy*-plane.

The line selected for demonstrating this computation technique has been tested with the model device designed by H W Semar of Westinghouse (POWER, October, 1940) under the direction of Mr J D Conrad of the same company. In this and other cases, tests verified computation results.



X,Y,Z..... Reactions and directions of positive coordinate axes

24" pipe Sched. 40 $I = 3423\ in^4$

24" pipe corrugated $I_c = \frac{I}{5}$ in bending

24" pipe corrugated $I_c = I$ in torsion

Expansion 3.7" in 100 ft

$\Delta X = \frac{3.7''}{100}(103' - 14') = 3.3''$

$\Delta Y = $ " $23' = 0.85''$

ΔZ " $49' = 1.81''$

$\Delta x\ E = \frac{3.3''}{12} \times 29 \times 10^6 \times 12^2 = 1{,}142 \times 10^6$ lb per ft

$\Delta y\ E = \frac{0.85''}{12} \times$ " $= 296 \times 10^6$ "

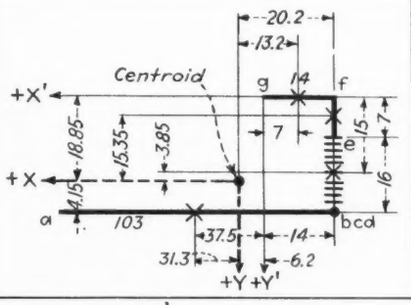
$\Delta z\ E = \frac{1.81''}{12} \times$ " $= 650 \times 10^6$ "

For plain pipe : $\frac{1}{I} = \frac{12^4}{3423\ in^4} = 6.06$

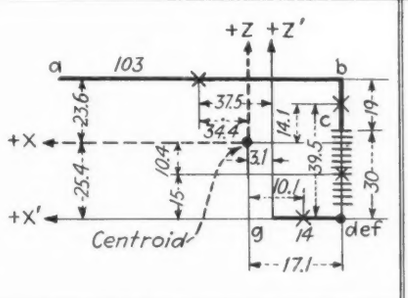
For corrug pipe : $\frac{1}{I_c} = \frac{12^4}{3423\ in^4} \times 5 = 30.3$

PROJECTION

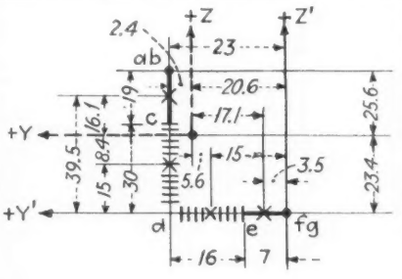
XY – Plane



XZ – Plane



YZ – Plane



CENTROID

	$l' = \frac{l\ ft \times 12^4}{I\ in^4}$	x'	l'x'	y'	l'y'
ab	6.06 x 103 = 625	37.5	23,400	23	14,380
bcd	6.06 x 49 x 1.3 = 386	-14	-5,420	23	8,870
de	30.3 x 16 = 485	-14	-6,800	15	7,270
ef	6.06 x 7 = 42	-14	- 595	3.5	148
fg	6.06 x 14 = 85	-7	- 595	0	0
	1,623		9,990		30,668

$\bar{X} = \frac{9{,}990}{1{,}623} = 6.2$ $\quad \bar{Y} = \frac{30{,}668}{1{,}623} = 18.85$

	$l' = \frac{l\ ft \times 12^4}{I\ in^4}$	x'	l'x'	z'	l'z'
ab	6.06 x 103 = 625	37.5	23,400	49	30,600
bc	6.06 x 19 = 115	-14	-1,610	39.5	4,540
cd	30.3 x 30 = 909	-14	-12,700	15	13,600
def	6.06 x 23 x 1.3 = 181	-14	- 2,540	0	0
fg	6.06 x 14 = 85	-7	- 595	0	0
	1,915		5,955		48,740

$\bar{X} = \frac{5{,}955}{1{,}915} = 3.1$ $\quad \bar{Z} = \frac{48{,}740}{1{,}915} = 25.4$

	$l' = \frac{l\ ft \times 12^4}{I\ in^4}$	y'	l'y'	z'	l'z'
ab	6.06 x 103 x 1.3 = 811	23	18,650	49	39,740
bc	6.06 x 19 = 115	23	2,645	39.5	4,540
cd	30.3 x 30 = 909	23	20,900	15	13,630
de	30.3 x 16 = 485	15	7,275	0	0
ef	6.06 x 7 = 42	3.5	1,470	0	0
fg	6.06 x 14 x 1.3 = 111	0	0	0	0
	2,473		50,940		57,910

$\bar{Y} = \frac{50{,}940}{2{,}473} = 20.6$ $\quad \bar{Z} = \frac{57{,}910}{2{,}473} = 23.4$

I_{xy}

	l'	x	y	l'xy
ab	625	31.3	4.15	81,200
bcd	386	-20.2	4.15	-32,400
de	485	-20.2	-3.85	37,600
ef	42	-20.2	-15.35	13,000
fg	85	-13.2	-18.85	21,200

$I_{xy} = 120{,}600$

I_{xz}

	l'	x	z	l'xz
ab	625	34.4	23.6	507,000
bc	115	-17.1	14.1	- 27,800
cd	909	-17.1	-10.4	161,300
def	181	-17.1	- 25.4	78,500
fg	85	-10.1	- 25.4	21,800

$I_{xz} = 740{,}800$

I_{yz}

	l'	y	z	l'yz
ab	811	2.4	25.6	49,800
bc	115	2.4	16.1	4,440
cd	909	2.4	-8.4	- 18,300
de	485	-5.6	-23.4	63,400
ef	42	-17.1	-23.4	16,750
fg	111	-20.6	-23.4	53,700

$I_{yz} = 169{,}790$

I_x and I_y

I_x:

ab	$625 \times 4.15^2 = 10{,}750$
bcd	$386 \times 4.15^2 = 6{,}650$
de	$30.3\left[\frac{16^3}{12} + 16 \times 3.85^2\right] = 17{,}500$
ef	$6.06\left[\frac{7^3}{12} + 7 \times 15.35^2\right] = 10{,}180$
fg	$85 \times 18.85^2 = 30{,}100$
	$I_x = 75{,}180$

I_y:

ab	$6.06\left[\frac{103^3}{12} + 103 \times 31.3^2\right] = 1{,}162{,}000$
bcd	$386 \times 20.2^2 = 157{,}200$
de	$485 \times 20.2^2 = 198{,}000$
ef	$42 \times 20.2^2 = 17{,}100$
fg	$6.06\left[\frac{14^3}{12} + 14 \times 13.2^2\right] = 16{,}150$
	$I_y = 1{,}550{,}450$

I_x and I_z

I_x:

ab	$625 \times 23.6^2 = 348{,}000$
bc	$6.06\left[\frac{19^3}{12} + 19 \times 14.1^2\right] = 26{,}400$
cd	$30.3\left[\frac{30^3}{12} + 30 \times 10.4^2\right] = 166{,}000$
def	$181 \times 25.4^2 = 116{,}800$
fg	$85 \times 25.4^2 = 54{,}800$
	$I_x = 712{,}000$

I_z:

ab	$6.06\left[\frac{103^3}{12} + 103 \times 34.4^2\right] = 1{,}290{,}000$
bc	$115 \times 17.1^2 = 33{,}600$
cd	$909 \times 17.1^2 = 266{,}000$
def	$181 \times 17.1^2 = 53{,}000$
fg	$6.06\left[\frac{14^3}{12} + 14 \times 10.1^2\right] = 10{,}000$
	$I_z = 1{,}652{,}600$

I_y and I_z

I_y:

ab	$811 \times 25.6^2 = 532{,}000$
bc	$6.06\left[\frac{19^3}{12} + 19 \times 16.1^2\right] = 33{,}200$
cd	$30.3\left[\frac{30^3}{12} + 30 \times 8.4^2\right] = 132{,}000$
de	$485 \times 23.4^2 = 266{,}000$
ef	$42 \times 23.4^2 = 23{,}000$
fg	$111 \times 23.4^2 = 60{,}800$
	$I_y = 1{,}047{,}000$

I_z:

ab	$811 \times 2.4^2 = 4{,}660$
bc	$115 \times 2.4^2 = 662$
cd	$909 \times 2.4^2 = 5{,}230$
de	$30.3\left[\frac{16^3}{12} + 16 \times 5.6^2\right] = 25{,}600$
ef	$6.06\left[\frac{7^3}{12} + 7 \times 17.1^2\right] = 12{,}500$
fg	$111 \times 20.6^2 = 47{,}000$
	$I_z = 95{,}652$

Sum of $I_x = 75{,}180 + 712{,}000 = 787{,}180$

Sum of $I_y = 1{,}550{,}450 + 1{,}047{,}000 = 2{,}597{,}450$

Sum of $I_z = 1{,}652{,}600 + 95{,}652 = 1{,}748{,}252$

$$787{,}180\,X - 120{,}600\,Y - 740{,}800\,Z = 1{,}142 \times 10^6$$
$$-120{,}600\,X + 2{,}597{,}450\,Y - 169{,}790\,Z = 296 \times 10^6$$
$$-740{,}800\,X - 169{,}790\,Y + 1{,}748{,}252\,Z = 650 \times 10^6$$

$X = 3{,}160$ lb $\quad Y = 375$ lb $\quad Z = 1{,}750$ lb

Reacting couples at "g"

in xy-plane

$+3160\ lb \times 18.85' - 375\ lb \times 6.2' = +57{,}000$ ft lb

in xz-plane

$-3160\ lb \times 25.4' + 1{,}750\ lb \times 3.1' = -74{,}700$ ft lb

in yz-plane

$-375\ lb \times 23.4' + 1{,}750\ lb \times 20.6' = +27{,}300$ ft lb

Diesel-Steam Plant Heats and Powers

Steam engines operate according to demand for exhaust, diesels take the rest of the load. With diesel jacket water used to preheat makeup for boilers, effective heat balance results

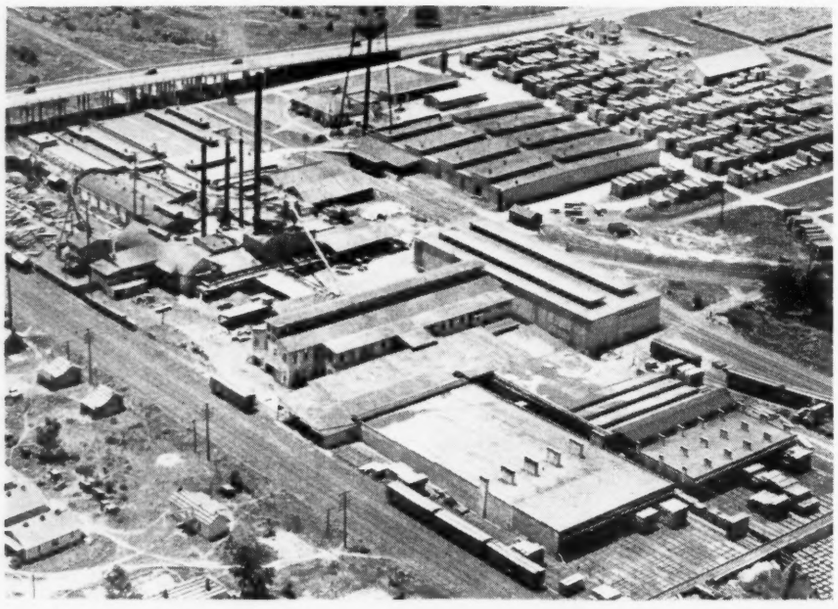


Fig. 1—Aerial view of Nickey Bros lumber mill, Memphis, Tenn.

► ADDING DIESELS to an existing steam plant to meet load formerly supplied with purchased power brought process-steam and power production into balance at the Nickey Bros lumber mill in Memphis, Tenn. Results have convinced the company of the wisdom of continuing full private generation, notwithstanding availability of TVA power.

The mill requires large quantities of steam for veneer production and other purposes; electric power loads reach peaks of 1100 kw. Four units supply this load: two steam engines, both more than 25 years old, and two new diesels. The larger steam engine, a 150-rpm Chuse non-releasing, cross-compound unit, drives a 500-kw General Electric alternator, while the smaller, a 225-rpm Skinner counterflow unit, drives a 125-kw Crocker-Wheeler generator. Steam for the engines comes from boilers fired with sawdust and shavings, the only fuel used.

Load in excess of the steam-engines' capacity was formerly supplied with purchased power, at more than two cents per kwhr. To handle this load more economically, a 600-hp diesel, driving a 400-kw generator, was installed in 1937. In May 1940, a 75-kw diesel-generator was added to handle night and weekend loads and to help out on peaks.

Under normal conditions, the Chuse engine runs 24 hours per day, to supply the steady demand for exhaust steam. Its electrical production averages 7000 kwhr per day. The large diesel runs about 10 hours a day, 6 days a week and produces about 3000 kwhr per day. The Skinner engine is operated as conditions require. The small diesel was installed primarily for night and week-end operation, at which time it carries the dry-kiln, fan, and lighting load. The small diesel is also used on peak loads. Division of load between diesel and steam units is adjusted to keep exhaust to atmosphere at a minimum.

Cooling Systems

The diesel cooling systems are tied into the heat balance, jacket heat being used to raise makeup temperature. Raw makeup comes from a 420-ft well, at 64 F. Passage through a heat exchanger, where it picks up heat from the closed jacket-water circuit, raises water temperature to 100 F. No exhaust-gas-heaters were installed, as present heat balance is just right. Should need for heat increase, a waste-heat boiler will be installed.

A centrifugal pump circulates soft water in the closed jacket-water circuit: condensate is used for makeup. A motor drives the jacket-water and raw-water pumps, which take water from a tank supplied by the well pump, pass it through the heat exchanger and then send it to the boiler-feed tank.

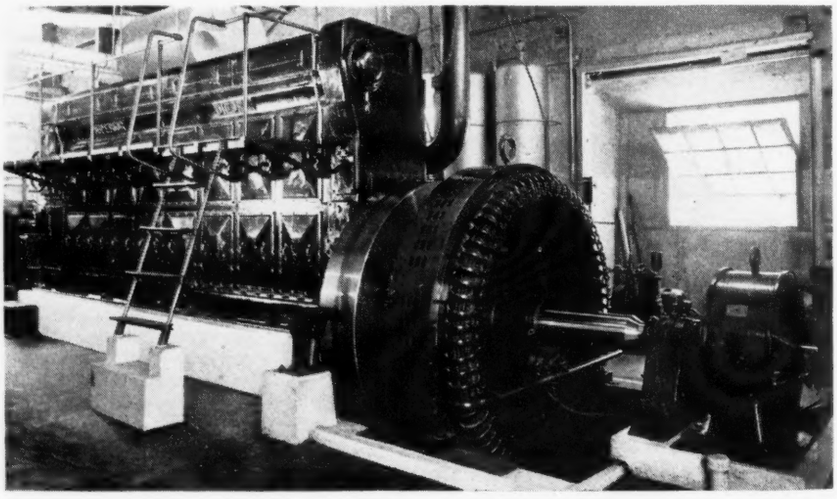


Fig. 2—This 600-hp diesel was installed in 1937 to handle load formerly supplied by purchased power

Lumber Mill

Fuel oil is stored in an 18,000-gal tank, elevated so that there is gravity flow to a 600-gal tank just outside the engine room. From this the engine-driven pump draws fuel through a cartridge filter and meter. Fuel-injection system is the common-rail type.

Engine Lubrication

The high-pressure side of a built-in engine-driven duplex gear pump delivers lube oil under pressure to all bearings and cylinders. Draining to the crankcase, the oil is picked up by the low-pressure section of the pump, which passes it through a cartridge filter and a shell-and-tube oil cooler to a 600-gal supply tank. High-pressure section of the pump takes its suction from this tank. In case the engine-driven pump should fail, the plant has a pair of rotary pumps gear-driven from a single motor. These auxiliary pumps are now used in cleaning the oil system.

Periodically, the oil (SAE 40) from the engine supply-tank is pumped to a 200-gal dirty-oil tank, and clean oil placed in the engine system. An activated-clay reclaimer purifies the dirty oil, which is then stored in a 300-gal clean-oil tank, until time to change again. Once a year, the operator adds a drum or two of SAE 30 oil to rectify the viscosity. Total consumption of lube oil by the large engine runs about 1 qt per day. A piston pulled for inspection at 10,000 hours showed all rings free.

An impingement filter protects the air intake of the large diesel. This is set high inside the engine room but within a ventilator section so that much of the air is drawn from outside the plant. A similar filter serves the smaller engine, but is mounted on the engine frame.

Exhaust gas passes from the engine headers up to vertical silencers mounted on a steel platform outside the building. Thermocouples fitted into the exhaust elbows leading from the cylinders, and a pyrometer with a multi-point switch, permit the operator to check exhaust temperature of each cylinder. The pyrometer, a tachometer, and essential pressure-gages are grouped conveniently near the control end of each engine.

Although there is usually a man on duty in the engine room, the engines are provided with safety alarms. A warning bell sounds if jacket water temperature exceeds 160 F, or if lube-oil pressure drops below 10 lb.

Use of waste products for fuel, and utilization of waste heat, make determination of production costs difficult at this plant. However, the large diesel has averaged somewhat better than 11.5 kwhr per gal. At 5 cents per gal for fuel oil and 19 cents per qt for lube oil, the cost per kwhr is 4.41 mills. This does not credit the engine with the heat supplied to the makeup water. Addition of the diesels required no additions to the labor force. The large engine has operated more than 14,000 hours without breakdown or repair.

Compared with the former cost of more than 2 cents per kwhr, the present cost of approximately half a cent (fuel, lube oil, maintenance) shows a saving that would pay for the units in five years. Even with TVA power rates cut sharply Nickey Bros calculate a profit in favor of running their own plant.

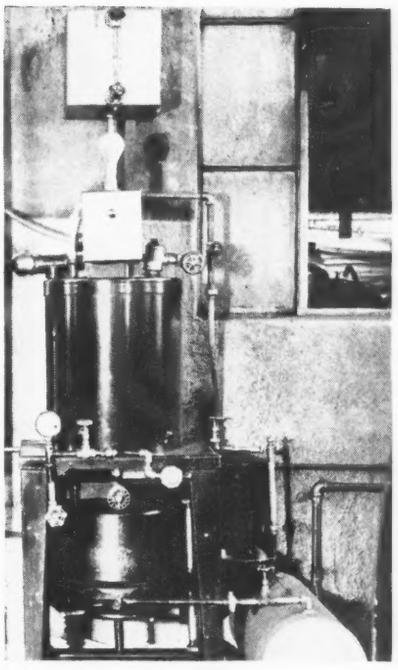


Fig. 4—Activated-clay reclaimer operates on batch system

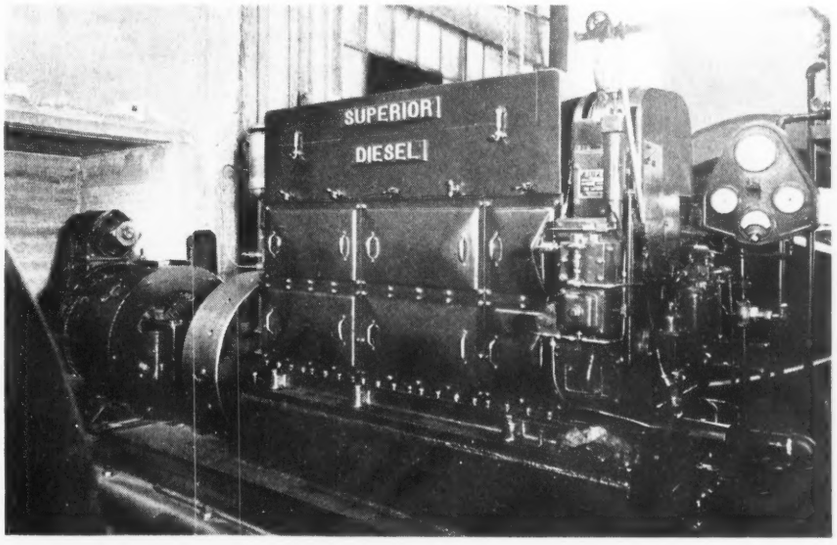


Fig. 3—For night and weekend loads, and for peaks, this 115-hp unit was added in 1940

Principal New Equipment

Nickey Bros, Memphis, Tenn.

Diesel engines	National Supply Co
One 600-hp, 400-rpm, 8-cyl, 12½x14-in. Superior engine	
One 115-hp, 720-rpm, 5-cyl, 7x9-in. Superior engine	
Generator, 400-kw, 480-v, 3-ph, 60-cy	Westinghouse Elec & Mfg Co
Generator, 75-kw, 480-v, 3-ph, 60-cy	Electric Machinery Corp
Fuel oil (Dieseline)	Shell Oil Co
Fuel meters (Niagara)	Buffalo Meter Co
Fuel filters	Purolator Products Co
Lubricating oil (Ring-free)	Macmillan Petroleum Corp
Lubricating-oil filters	Wm W Nugent & Co
Lubricating-oil reclaimer	Youngstown-Miller Co
Auxiliary and transfer pumps	Geo D Roper Corp
Jacket and raw-water pumps	Deming Co
Heat exchanger	Ross Heater & Mfg Co
Air filters	American Air Filter Co, Air-Maze Corp
Exhaust silencers	Maxim Silencer Co
Exhaust pyrometers (Alnor)	Illinois Testing Labs
Pressure gages	U. S. Gauge Co
Starting-air compressor	Curtis Pneumatic Machine Co
Switchboard	Shelby Electric Co
Switchboard instruments	Westinghouse Elec & Mfg Co
Voltage regulator	General Electric Co

Know Fire—To Put It Out

With industry "all out", fire-losses will increase unless extra care reverses the usual trend. A fire-protection engineer, H W Lange, Cardox Corp, shows how fires differ and how to fight each kind

▶ FIRE HAZARDS and fire-protection problems of power plants are not greatly different from those of industry. A fundamental understanding of what makes a fire burn, close to the experience of every power engineer, helps plan the putting out of different types of fire that may be encountered.

Combustion is oxidation taking place at such a rapid rate as to produce luminous flame. Most materials oxidize slowly all the time. Oxidation produces heat. If heat is produced fast enough, light (flame) results.

The first thought in extinguishing fire is the elimination of flame. Then comes elimination of possible sources of re-ignition, such as overheated flammable material or overheated surroundings. To be effective, a fire-extinguishing agent should not only put out the flame but also have a cooling action or fairly permanent smothering properties.

Several Methods

There are several common ways in which a fire may be extinguished. In order of practical importance, they are (1) cooling, (2) smothering and (3) separating flame from burning material.

Cooling is best represented by the action of water on wood fires; *smothering* is best pictured by covering a pan containing burning material; and *separating* the flame from the wood of a match by "blowing it out" is a common experience.

In the case of the burning match, the flame is blown away from the burning part so that it cannot heat the wood further and form combustible vapors. If the action is quick, we simply separate the flame from the flammable vapors; if the blowing is slow, we push the flame aside to decrease the generation of vapors.

It is convenient to separate fires into three classes: (A) involving wood, textiles, rubbish and the like upon which the cooling action of an extinguishing agent is of first importance; (B) involving flammable liquids upon which smothering action of an extinguishing agent is essential and, (C) involving electric current where extinguishing agent must be a nonconductor to prevent endangering human life, and to avoid causing additional short circuits.

Water, most abundant liquid in the world, is fortunately one of the best fire-extinguishing agents, adaptable to the most common type of fire, class A. To raise the temperature of a lb of water and vaporize it takes over 1000 Btu away from a fire. When water is used to extinguish a deep-seated fire, burning material is cooled not only by the few Btu's necessary to heat the water but also by the many it takes to evaporate the entire amount.

Water is Plentiful

Water is thus primarily suitable for wood or textile fires that require cooling of large masses of glowing embers before extinction can be finally accomplished. Under certain conditions performance of water as an extinguishing agent can be improved somewhat by the addition of certain fire-proofing chemicals such as salts of ammonia, potash or lime.

Heat transmission depends partly on exposed area. Water in finely divided form exposes a great total area to the flames into which it is directed, robs the flames of heat, cools a liquid surface, and retards release of flammable vapors. Recent developments have produced atomizing nozzles which, though they have not the range of solid fire streams, provide more efficient application with less water damage.

Hand extinguishers employing water as the main agent are made in a number of designs. The most common type is the soda-acid unit employing a solution of sodium-bicarbonate in the main chamber with a suspended bottle of sulphuric acid above. When the extinguisher is inverted the acid and soda react to form carbon-dioxide gas which creates a pressure for discharging the solution through hoze and nozzle in a continuous, easily directed stream. The main purpose of the chemicals is to provide pressure; they do not add a measurable fire-extinguishing effect over that afforded by plain water.

Another type of extinguisher, similar in appearance and operation, employs a carbon-dioxide pressure cartridge, which, when punctured, provides for ejecting the water. An ordinary hand-pump unit is also available.

Calcium chloride is mixed with the water in the latter types where freezing temperatures are encountered. The freezing point of the liquid can be depressed to as low as —50 F.

For electrical equipment, carbon-tetrachloride extinguishers were among the first employed and still have an important function in power-plant fire protection. Either the 1-qt pump-type or the 1-gal pressure-type are effective on small fires likely to occur near switchboards or electrical galleries. The primary extinguishing action is smothering.

The vaporizing liquid readily evaporates when played on hot surfaces and forms a heavy fire-smothering gas. Only about 100 Btu per lb are needed to evaporate the liquid so that much less cooling effect is available for glowing embers than with water.

Recent Dry Types

Extinguishers have recently been developed that employ a dry compound. In hand sizes, powder is forcibly ejected as a dust cloud when a carbon-dioxide pressure cartridge within the extinguisher is punctured. The dust of this special compound is effective in sweeping the flame from a burning surface, cooling and smothering the fire. The compound is essentially sodium-bicarbonate with additives to keep it in powdery condition.

Application of any extinguishing agent in a continuous, directed stream is most efficient. Most hand extinguishers are so designed that any headway gained in controlling the flame can be followed up with the greatest possible effectiveness.

Foam is a quenching medium that provides a smothering blanket when properly applied. The foam extinguisher, similar to the soda-acid type,

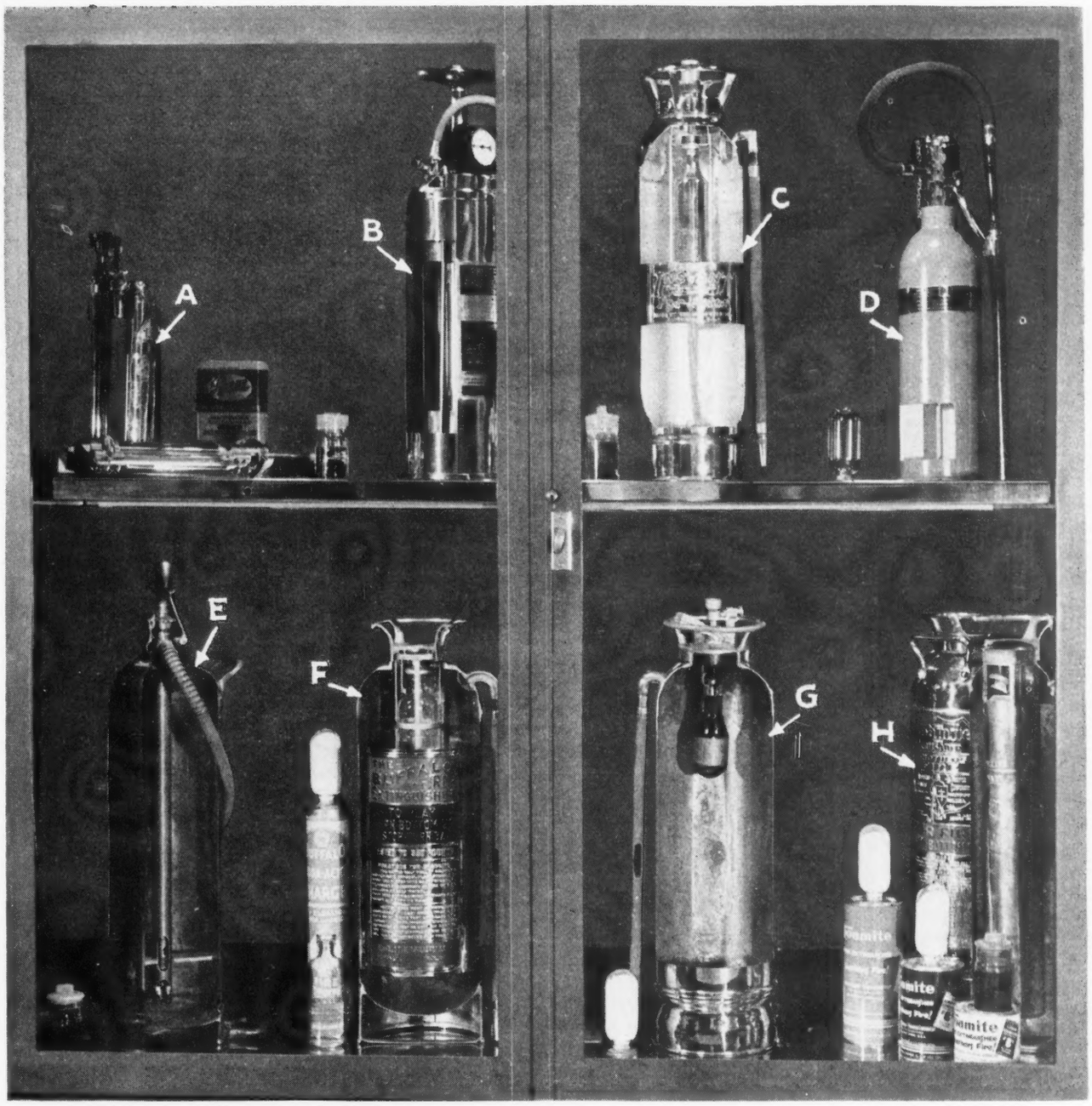


Fig. 1—Hand fire-extinguisher display at Underwriters' Laboratories: A—1-qt vaporizing-liquid, B—1-gal vaporizing-liquid, C—loaded-stream, D—4-lb carbon-dioxide, E—hand pump for water, F—2½-gal soda-acid, G—2½-gal cartridge, H—2½-gal foam

contains sodium-bicarbonate solution with a foaming agent added. This makes a difference in performance best illustrated by the analogy of drawing off beer from a keg and soda water from a siphon bottle. The beer has a stable foam because of the malt and hops, whereas the froth quickly dissipates from the simple water-and-carbon dioxide solution. Standing 15 minutes, fire-extinguishing foam shrinks only about 10% and is not rapidly broken down by flame.

Foam extinguishes mostly by smothering, as it floats or rests on flammable surfaces. There is some cooling action, however, as 20 gal of foam contains approximately 2½ gallons of water.

Carbon dioxide is a relatively inert gas that has many remarkable characteristics and for which many interesting uses have been developed. It is employed in refrigeration, medicine, beverages, as an exterminator and even for dislodging coal in mines. In solid form, it is the familiar dry ice. At normal temperatures and pressures, carbon dioxide exists as a gas. It forms part of the earth's atmosphere, is liberated by the combustion of practically all fuels, is given off by fermentation during the formation of alcohol and is exhaled by animals. It can be compressed and liquified. The latter characteristic makes it adaptable to storage for fire-extinguisher use.

Many sizes of storage cylinders for carbon dioxide are available. Popular hand varieties hold 15 lb. Liquid fills 68% of the cylinder volume and pressure within is always 850 lb at 70 F. This pressure, however, varies greatly with temperature change. This characteristic has been employed in the recent development of low-pressure storage containers for large quantities, in which the pressure is held at a low value by refrigeration. Bulk low-pressure storage of tons of carbon dioxide is thus possible.

Hand and portable carbon-dioxide ex-

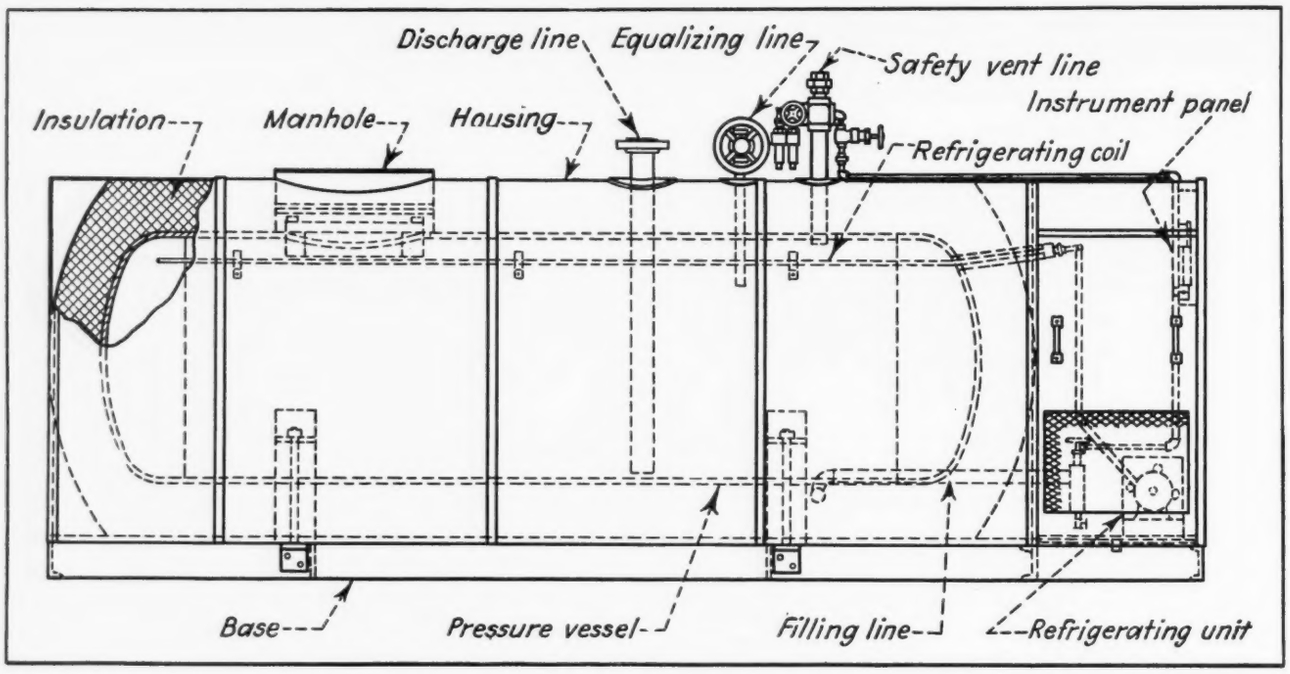


Fig. 2—Low-pressure container for storing large quantities of carbon dioxide under refrigeration. These containers afford plentiful supply for hose reels for portable application and for fixed installations to protect transformers or other power equipment

tinguishers have long been popular for installations where equipment to be protected is valuable or where a non-damaging extinguishing agent is desired. Extinguishing action of carbon dioxide is that of smothering accompanied by considerable cooling due to the formation of "snow," at —110 F, during discharge of the gas. The amount of snow formed depends on initial temperature of the liquid within the cylinder. At 86 F, the cooling action available is about 50 Btu per lb (to 100 F) as compared with about 150 Btu per lb when the stored liquid is at zero F.

Carbon Dioxide Smothers

Since carbon dioxide acts mostly by smothering, extremely rapid and effective action can be secured if entire rooms, generator housing or switching compartments are flooded. By injection of carbon dioxide to a 37% concentration in an enclosed space, the atmosphere can be made inert, so that it will not support combustion of ordinary flammable materials. When called into operation, the carbon dioxide causes no damage additional to that caused by the fire itself.

Ability to store carbon dioxide in quantities up to 125 tons under refrigeration has increased the power of this fire-fighting tool. Mass storage leads to more generous use of the material, better control of timed discharge, and application to outdoor hazards such as transformer installations. With adequate quantities of carbon dioxide available, protection of oil-containing equipment outdoors can be assured, even when severe winds prevail.

Whether the fire-protection problem requires only addition of a hand extinguisher on a convenient wall or provision for complete automatic smothering of a central-station electrical gallery, proper use of the best-suited fire extinguisher is planned before, not after, the fire starts.

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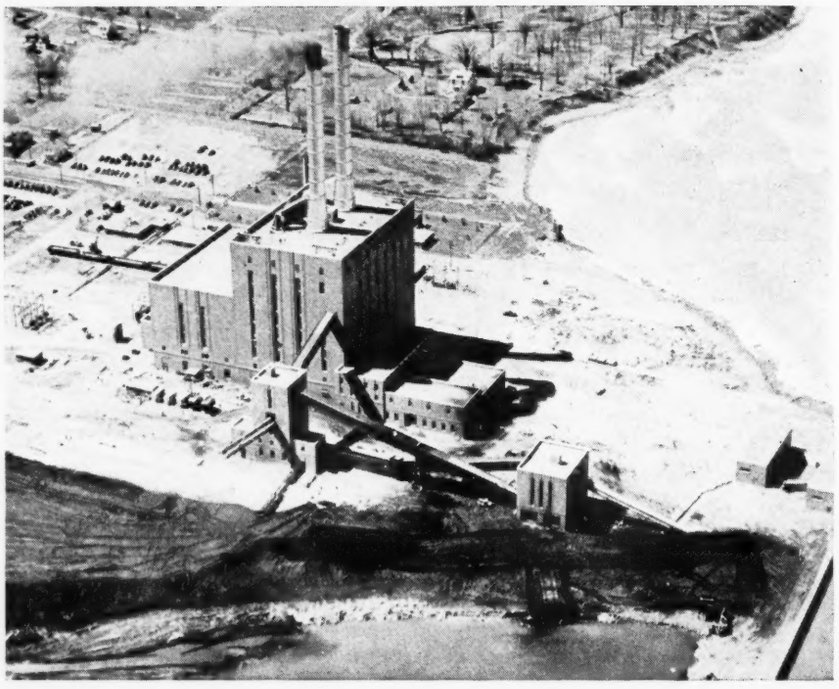
Oswego No. 2 Placed in Service



Halfway between Niagara Falls and the proposed St Lawrence waterway development stands Oswego Steam Station of the New York Power Corp with one 80,000-kw unit already in operation for over a year and a duplicate recently placed in operation. With the new unit, the Niagara-Hudson System has about 200,000 kw of net assured capacity over that required to serve present loads

Quiet, Please!

Phoning from a 100-decibel turbine room used to take real concentration. A standard sound-protected steel booth with some ingenious additions accommodates three telephones and keeps out much of the noise

By GEORGE METZ
Consolidated Edison Co of New York

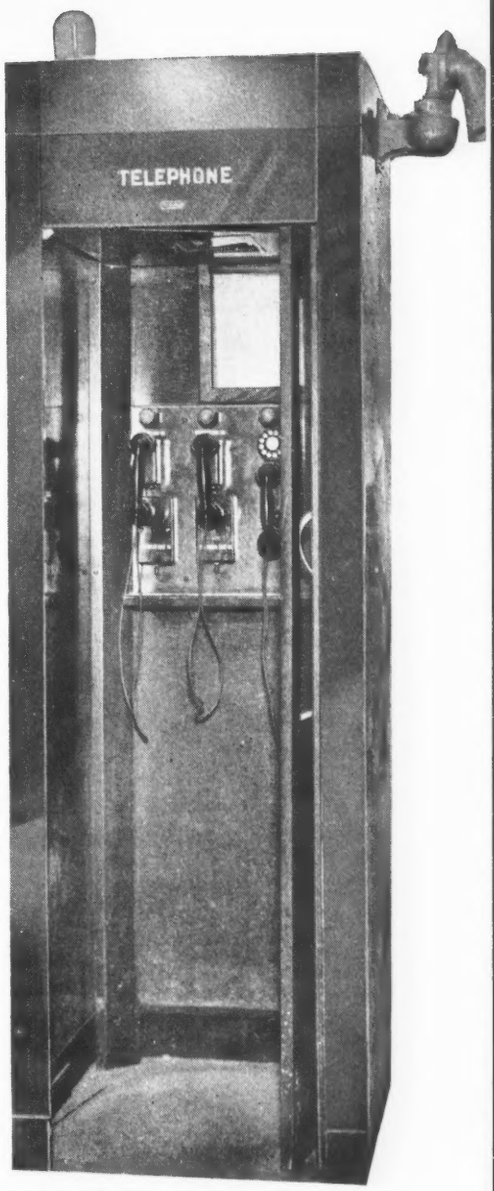


Fig. 1—Three phones hang conveniently from the rear wall. All relays and signal equipment are on the roof. Operators asked for the door

▶ A MINOR ITEM in a quarter-million-kw construction program, sound-protected telephone booths are necessary to efficient communication amid the high-pitched hum of 3600-rpm turbines. With a few modifications, a standard steel booth with 1½-in. rockwool lining covered by a protective surface of sheet metal has been reported comfortable and convenient by the operating staff.

Jointly developed by the manufacturer, the New York Telephone Co and the Consolidated Edison Co, the booth shown was designed for noise levels up to 100 decibels, for the accommodation of several instruments and for both audible and visible signals. In addition, general durability and reasonable moisture resistance were required.

Folding-Door Booth

The folding-door booth was selected after tests by the operators who were eventually to use the phones. Sound-level readings taken within the booth with the door open and closed indicated only a slight reduction in decibel-level when the door was closed. To the human ear, however, the door closing seemed to have a pronounced effect upon the comfort with which conversation could be carried on. Another consideration in selecting the standard door-type booth was its compactness, space being somewhat limited.

To accommodate three telephones (two private boiler-operator lines and a third house-system phone) hang-up hand-set instruments were selected. The multiplicity of equipment resulting from three lines to the booth suggested the novel expedient of disposing of all relays and signal equipment in a compartment especially constructed on the roof of the booth. This location removes all the electrical equipment from the area of accidental jarring or possible tinkering. While not as convenient for telephone wiremen, the roof location has eliminated many of the other faults to which ordinary booth equipment is usually subjected.

The corner pipe stanchion and shelf with which the standard booth is usually equipped, were replaced with a sheet-metal corner raceway and a steel back-plate, blocked out from the rear wall. Instruments and pilot lights were mounted on this plate and all wiring concealed within a raceway behind the plate.

When several booths are closely adjacent, a single audible signal serves all; the particular booth is identified by a flashing light mounted above. The particular phone shows a glowing pilot light immediately over the instrument.

The most effective audible signal to pierce the drone of station equipment was determined by test to be a klaxon horn sounded intermittently at intervals of approximately one-half second. An induction-motor flasher gives the signal spacing.

Baked-enamel finish on the steel surfaces provides necessary moisture protection. It was found desirable to provide the booths with a heavy, galvanized-iron top plate constructed in one piece and flanged over the side walls, as the booths are occasionally subjected to drips from above.

Several of the booths have been in service for a year, long enough to establish their convenience and effectiveness, as well as freedom from maintenance.

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First Section of Venice Nearly Complete

▶ WITH CONSTRUCTION SCHEDULE calling for commercial operation of the first 40,000-kw unit at Venice No. 2 plant of the Union Electric Co (St. Louis, Mo.) by December, building construction and equipment installation is proceeding rapidly. First of two new boilers will start supplying steam to Venice No. 1 about October 15, increasing peak capacity about 20,000 kw by removing a boiler-room limitation.

The second 40,000-kw turbine will be ready for operation in February, and much work is already completed on two projected units of 80,000 kw each. The first of the larger turbines is scheduled for early 1943 operation; second has only recently been ordered.

Boiler-Water Concentration Can Be

Cedar Rapids tests indicate that boiler-water concentration below optimum range may increase carryover in steam

By W L STARKWEATHER
Chemical Engineer, Iowa Electric Light & Power Co

► WITH THE TREND definitely toward the conductivity method of determining boiler-water carryover and steam purity, our experience at this station should be of interest. Our old plant was topped in June, 1939, with a Springfield cross-drum, sectional header, straight-tube boiler with a capacity of 250,000 lb per hr at 700 lb and 750 F. The 5000-kw high-pressure turbine exhausts to the old header at 210 lb. Normally this turbine generates 6000 kw, utilizing the entire 250,000 lb steam output. A similar boiler of 300,000 lb per hr capacity is ready for operation and a 700-lb, 15,000-kw extraction and condensing turbine is being installed.

Make-up runs as high as 60% daily average in winter (with peaks of 75%) and averages about 20% in summer. Cedar River water, clarified and partially softened by the city, is taken for raw make-up. Treatment consists of filtration, zeolite softening, sulphuric acid addition for adjustment of ratios and aeration in the treated-water storage tank. Sodium sulphite and monosodium phosphate are added at the feedpump suction to control oxygen and hardness in the boiler feed after deaeration. Table 1 shows typical water analyses.

A steam-sample tube was inserted in the saturated header at a point in a vertical section, providing about 15 ft straight downward run. Steam was condensed continually under pressure and allowed to flow through a brass chamber containing a Leeds & Northrup conductivity cell.

Recording equipment was a 6-point Micromax conductivity recorder with a range of 2500 to 500,000 ohms. Three other condensate records were printed on the instrument. Two points were

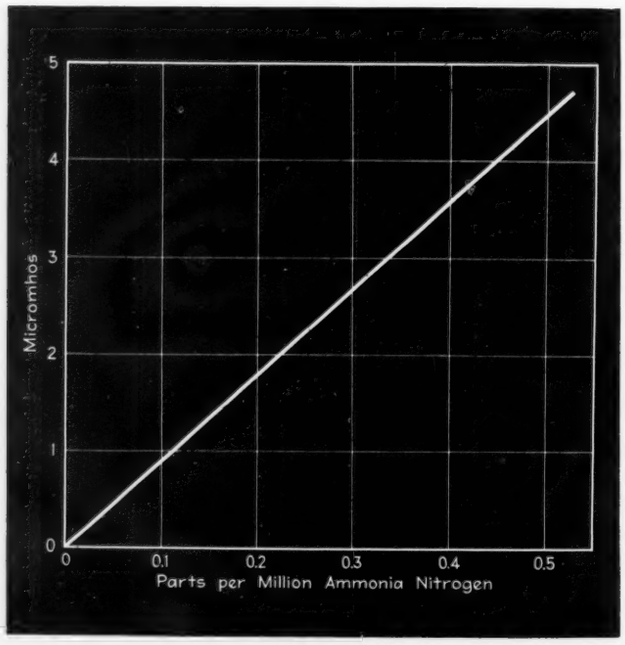


Fig. 1—Correction to conductivity readings for ammonia in steam at 77 F

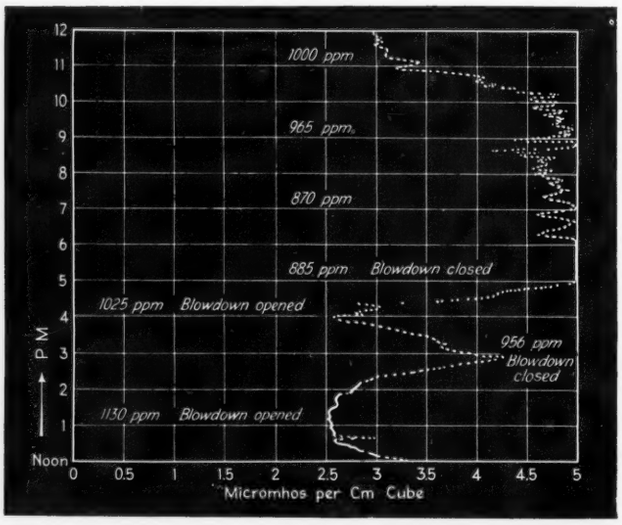


Fig. 2—Conductivity-meter chart shows effect on purity of deliberate lowering and raising of boiler-water concentration

TABLE I—TYPICAL WATER ANALYSES

parts per million

	Raw	*Treated make-up*	*Boiler*
Ph alkalinity as $CaCO_3$	3	...	145
MO alkalinity as $CaCO_3$	75	35	171
Total hardness as $CaCO_3$	115	3	...
Sodium Chloride as Nacl	21	22	132
Sodium Sulphate as Na_2SO_4	...	113	678
Sodium Sulphite as Na_2SO_3	...	...	17
Sodium Phosphate as $Na_2H\ PO_4$	...	...	12
Silica	8	8	30
$Na_2SO_4 \div NaOH$	...	...	7

TABLE II—TOTAL SOLIDS BY EVAPORATION

Sample No.	*Date*	*Sample size*	*Total solids boiler*	*Total solids steam*	*Conductance micromhos*
1	3–26–40	16 L	760	1.33	Undegassified
2	4– 2–40	12 L	880	0.9	Undegassified
3	4–11–40	12 L	1030	0.6	Undegassified
4[1]	4–18–40	11 L	1132	3.5	Undegassified
5[2]	12–26–40	10 L	1270	1.04	2.35[3]

1 Carryover indicated
2 Sample taken while ocr 1100-1300 ppm
3 Equivalent to 1.06 ppm

Too Low

available for steam record. A dip-type cell and portable conductivity indicator were used to check samples in the laboratory.

Degassing of the sample could not be expected because it was condensed under pressure; no continuous degassing method seemed suitable. We assumed that gas liberation would be steady and that a straight record would indicate minimum boiler-water carryover. Subsequent operation upheld this assumption.

The fact was soon established that about 1100 to 1150 ppm total solids was the critical concentration of the boiler water. Above this concentration definite slugs of water—as much as 2 to 3%—would be sent over spasmodically with the steam. The point for normal operation was therefore fixed at 1000 ppm.

When concentration was increased gradually there was a steady purity record with no indication of approach to the critical point. Gas liberation was steady, but varied in total amount with seasonal changes in water quality. Gas in steam samples in summer amounted to about 12 ppm CO_2 and 0.1 ppm ammonia nitrogen. In winter, gas ran as high as 20 to 22 ppm CO_2 and 0.3 ppm ammonia nitrogen.

These high values precluded any attempt to correct indicated resistance to the gas-free basis. Only evaporation of 10- to 15-liter samples in a dust-free atmosphere, with correction for iron and silica in the weighed residue, was felt reliable as a test for total solids in the steam. It required from 75 to 85 hours to evaporate samples at a very low boiling point in a large sillimanite dish. Iron from the sampling tubing and silica from the glass and dish were not considered soluble solids in the original steam sample; they were determined and deducted from the total residue on evaporation. Table II shows the results of a series of evaporations.

The definite trend toward better steam purity with increase of concentration from 760 to 1030 ppm was felt to cast some doubt on the reliability of the tests, since at that time it was contrary to any theory or accepted practice with which the writer was familiar. However, in 1930, Hecht and McKinney[1] noted an indication of this occurrence.

From the beginning we had felt a pressing need for a reliable and efficient continuous degassing device which could be located on the operating floor. Shortly after the data on the first four samples of Table II were collected, development of the Straub degassing condenser became known, and we arranged to obtain one of the first units. Knowing that this unit would remove all gas except a trace of ammonia, we purchased a 3-point Micromax recorder of range 0 to 5 micromhos. Gas-free sampling was expected to show less than 5 micromhos conductance on the steam.

The new degassing condenser and conductivity recorder were placed in operation November 16, 1940. To determine the conductance caused by 1 ppm of soluble solids for our water, we collected a sample of degassed steam by overflow and determined the conductance by the dip-cell and portable indicator. Increments of 0.2% of boiler water were added up to a total of 1% and the increase in conductance noted at each step. Table III shows the results of this determination, where one micromho was found equivalent to 0.45 ppm solids.

Since that time it has been established that the ppm per micromho may go up to 0.58 at certain periods, even with the same water source. This value should always be established at the time of the test.

The degassing condenser consistently gives zero ppm CO_2 and only traces of ammonia nitrogen in the steam sample. The latter is determined very simply with an improved type Hellige Aqua Tester and corrected for on the recorder by setting the temperature-compensator the proper number of degrees higher than sample temperature. It has been determined that a 10-degree change on the compensator corresponds to 0.3 micromho, which is in turn equivalent to 0.035 ppm ammonia nitrogen from the correction curve shown in Fig. 1. A correction of 9 micromhos was used as a basis for this curve.[2]

Results showed that normal conductance of the steam is about 2.25 micromhos, equivalent to about 1.1 ppm total solids, or about 0.1% boiler-water carryover. Also it was noted that the steam purity decreased at intervals nearly

[1] Hecht, Max and McKinney, D. S. *"Electrical Conductance Measurements of Water and Steam and Applications in Steam Plants."*

[2] Powell, Sheppard T, "Steam Contamination," *Combustion*, Sept, Oct, Nov, 1937.

TABLE III—TOTAL SOLIDS EQUIVALENT TO 1 MICROMHO

Boiler Water 1000 ppm

	Conductance micromhos	*Increase micromhos*	*ppm per micromho*
Condensate	3.10	.....	.....
plus 0.2% blr water	7.80	4.70	0.43
plus 0.4% blr water	11.70	8.60	0.46
plus 0.6% blr water	16.40	13.30	0.45
plus 0.8% blr water	20.80	17.70	0.45
plus 1.0% blr water	25.60	22.50	0.44
		Average	0.45

1 micromho equivalent to approximately 0.045% moisture

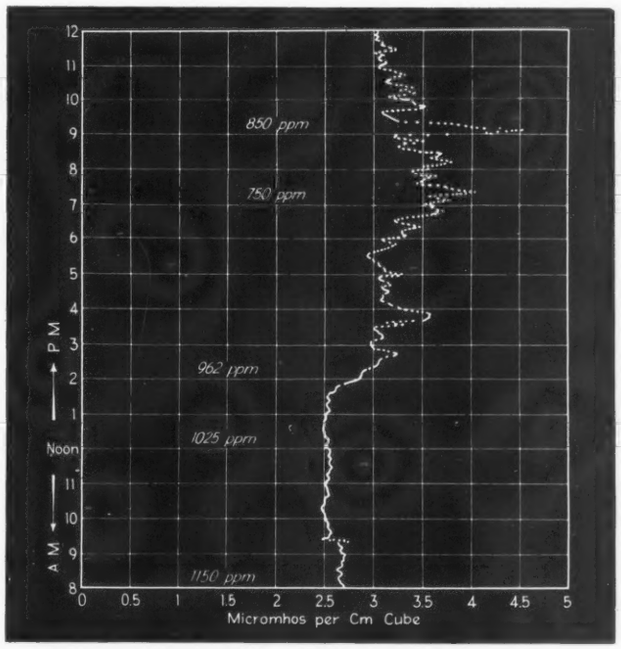
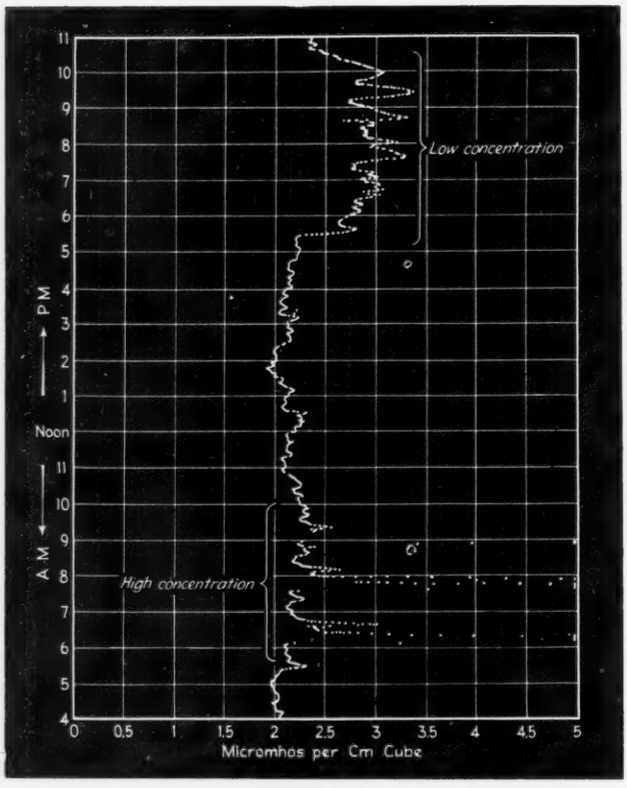


Fig. 3—Conductivity increases when boiler-water concentration falls below about 1000 ppm



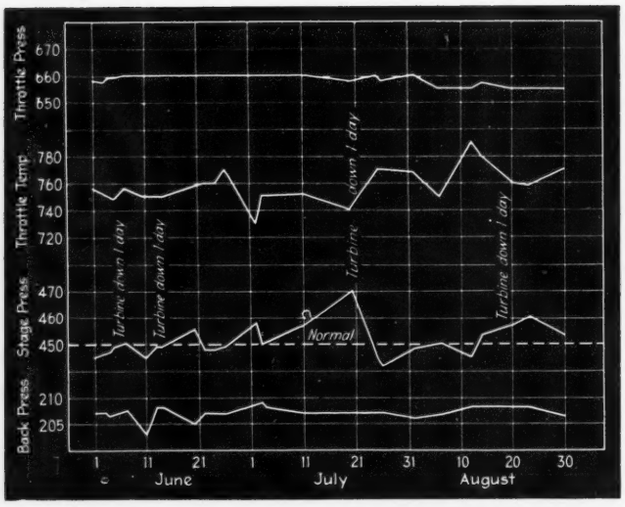


Fig. 5—Representative 3-months chart of turbine stage-pressure indicates that one-day shutdowns cause effective washing of the turbine during starting

Fig. 4—Typical chart for a day during which high concentrations caused slugs to be carried over and low concentrations resulted in increased conductivity readings.

every day at hours corresponding to station peak-load periods, although the boiler is a base-load unit and operates at 250,000 lb per hr about 20 hours each day. The same hours are peak makeup periods, but study showed that makeup was not the cause. Soot blowing and change of air-louvre settings were ruled out.

It became apparent that during these periods of poor quality the boiler-water concentration was generally under the operating point of 90% critical concentration, or about 1000 ppm. Fig. 2 shows the effect of deliberately lowering and raising the boiler-water concentration by regulating the continuous-blowdown valves. This appeared to prove that there was an optimum concentration range (ocr) below which the steam purity decreased with decrease in concentration and above which definite slugs of water were carried over.

The printed record of poor steam purity due to low concentration definitely is of a different type from that due to high concentration. Fig. 3 shows an actual chart with the concentration held below the low limit of ocr. Fig. 4 shows a day on which the upper and lower limits of ocr were passed. Neither boiler-water ratios nor pH could be correlated to the decrease in steam purity when below the ocr. It may be noted from the charts that one micromho increase in conductance is equivalent to an increase of approximately 0.045% moisture at our normal concentrations.

About the time this condition was being discovered and proved to our satisfaction, it was noted that boiler-water concentration of 1000 ppm (and even 1100) seemed to be too low for highest steam purity. Accordingly, concentration was raised and the critical upper limit of ocr was found to be about 1335 ppm. The lower limit of ocr had become about 1100 ppm. After five weeks of operating at 1200 ppm (ocr 1100 to 1335 ppm) the ocr dropped back to 1000 ppm as an operating concentration. Two months later we experienced a period of about 10 days when the ocr was about 850-1050 ppm. This required operating at 950 ppm.

Ocr May Change

These particular experiences seem to indicate that the ocr of an installation may change for some reason so far not discovered. Since the boiler-water analyses during these periods did not seem to vary—not even the ratio between the several ingredients changed appreciably—this fluctuation may be due to varying circulation or steaming characteristics of the boiler. The conditions as found here have provoked the thought that possibly some plants operating at higher pressures on a very few hundred ppm total solids might improve purity by increasing concentration.

Through the winter of 1939-40 the topping turbine fouled so rapidly that only about five or six weeks of operation were needed to raise the first-stage pressure 15%, requiring washing of the unit. This was accomplished by allowing the unit to cool down for 8 hours and then rolling it at ¼ to ⅓ speed while spraying feedwater into the steam line. Only about two hours of actual washing were required, the end point being determined by conductance of washings. It was noted that the ratio of Na_2SO_4 to NaOH had dropped to 2-3 and it was decided to decrease the treated makeup alkalinity from 50 ppm to 30-35 ppm. This would give a ratio, Na_2SO_4 to NaOH of 7 in the boiler and should materially increase the amount of dry material to coat sticky caustic particles. On March 31, 1940, the turbine was washed the last time and lowered alkalinity went into effect the next day. We required only a ratio capable of slowing the rate of deposit, so that it did not become objectionable in three to four months. It was known that a one-day shutdown period was usually enough to clean the turbine because of wet steam on starting up, and it was felt that either the boiler or turbine would be down at least a day every three or four months.

It may be mentioned here that the availability of the boiler from July 21, 1939 to April 15, 1941 has been 97%. Since the regulation of acid feed to maintain the ratio of 7 in the boiler no great increase in stage pressure has been noted, 450 lb being normal. Fig. 5 shows a representative 3-month period of stage-pressure data. It will be noted that on two occasions the shutdown was long enough to cause washing of the unit on starting up.

Practical Pumping Pointers

Frank A Kristal, Mechanical Engineer, tells how to apply characteristic curves when selecting centrifugal pumps and how to determine from these curves if a pump impeller-diameter or speed can be changed to make it operate under new condition

▶ WHEN A PURCHASER needs a centrifugal pump, it is necessary for him to determine the type of drive, capacity and pressure required. From this information and the service conditions, the pump manufacturer can recommend the most efficient and economical unit. Practically every pump manufacturer has his line laid out and designed to fit the various capacity and pressure ranges. Each pump-size has been carefully tested, and the results plotted on curves which indicate the range efficiently covered by every size.

Take a single-stage double-suction pump, having a 5-in. suction and 4-in. discharge opening, mounted on a cast-iron bedplate and driven through a flexible coupling by an induction motor, as built by one manufacturer. The manufacturer's curves for this particular pump are shown in Fig. 2, 3 and 4. Fig. 3 shows the factory-test results on this pump at a constant speed of 1750 rpm with various impeller diameters. After the pump was designed and the first unit built, it was tested with the maximum impeller diameter of 8 in. Then the impeller diameter was reduced to the next size of 7.25 in. and the same test repeated. These tests were also made with the impeller reduced to 6.5 in. and 5.75 in. in diameter. This last size is the minimum impeller diameter for 1750 rpm, since efficiency starts to decrease rapidly with this diameter.

Speed Kept Constant

When each test was made the speed was kept at 1750 rpm, the head was varied by throttling the discharge valve to get head readings from full opening and maximum capacity all the way to the maximum head at shutoff, with the discharge valve closed. Water-discharge capacities in each case were determined by means of a weir, a tested nozzle, or a Venturi meter. Total net heads were determined by reading tested gages on pump suction and discharge. Brake-horsepower input for each rating was determined either by using a dynamometer between the driving motor and pump being tested, by an electric dynamometer to drive the pump, or from characteristic curves of the driving motor. Having the pump capacity in gallons per minute, and the total head in feet, with the brake horse-

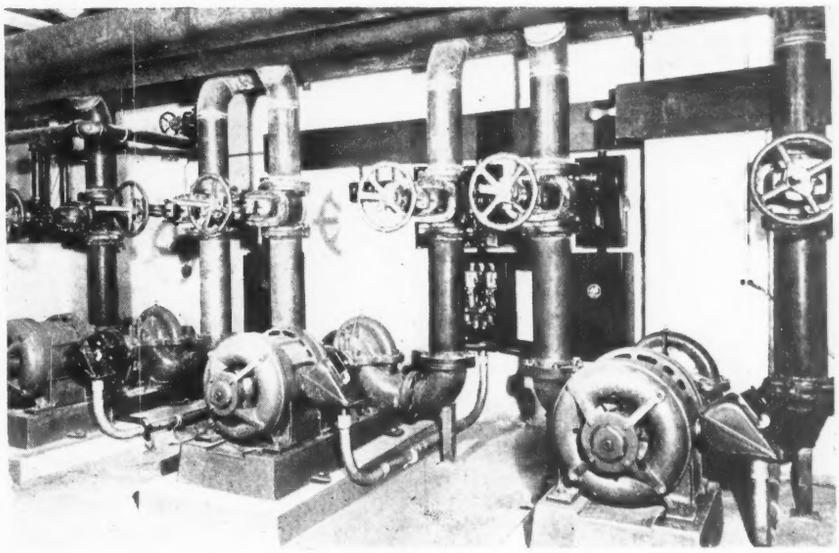


Fig. 1—A centrifugal pump can be used for a wide variety of applications by changing its impeller diameter or speed

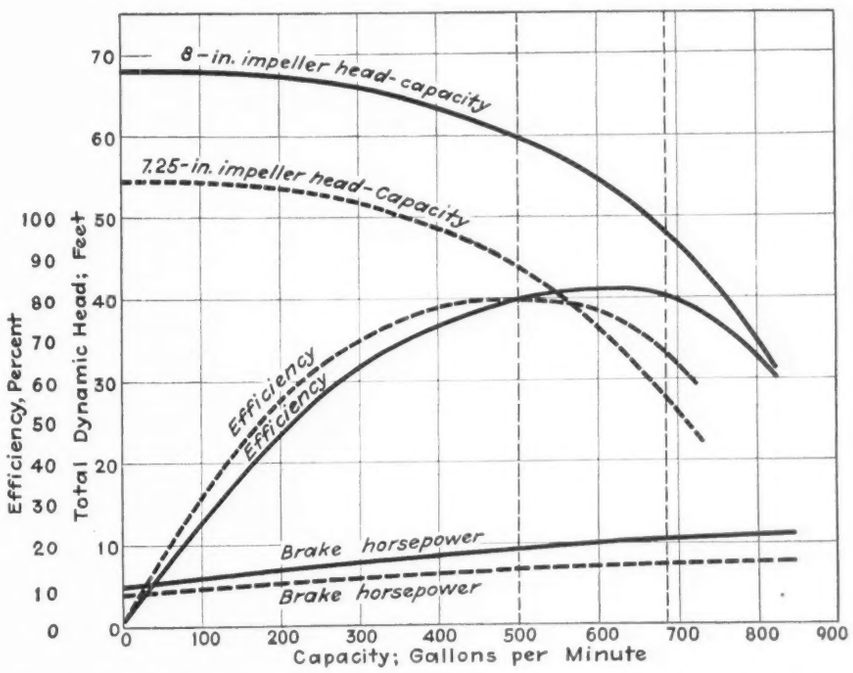


Fig. 2—Characteristic curves for a 4-in. centrifugal pump with an 8-in. and a 7¼-in. impeller when operating at 1750 rpm

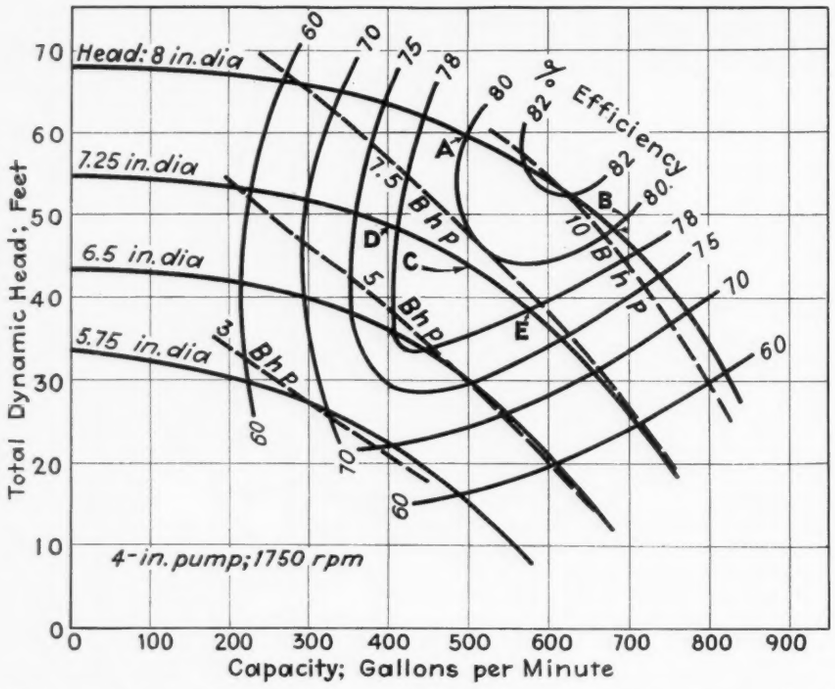


Fig. 3—Family of characteristic curves obtained from tests on a 4-in. centrifugal pump with 4 different-sized impellers operating at 1750 rpm

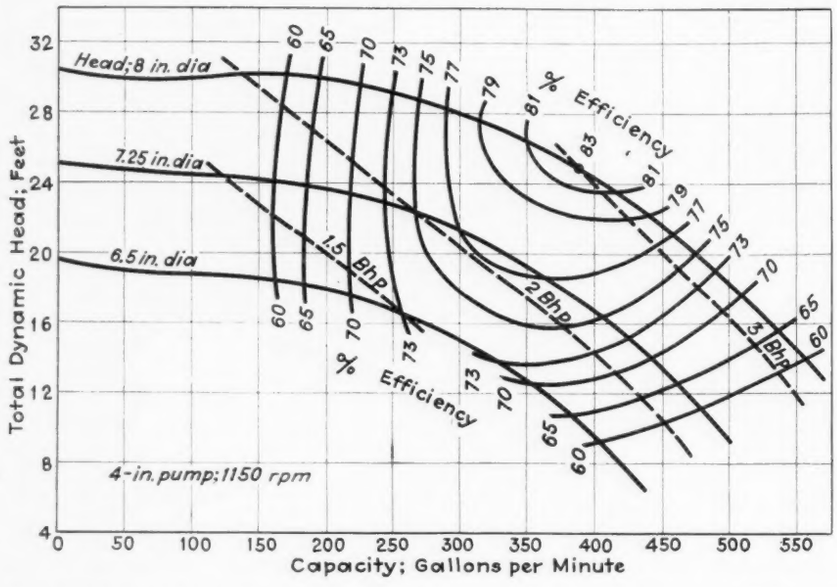


Fig. 4—Characteristics of the same pump used in Fig. 3, operating at 1150 rpm

power, the pump efficiency for each set of readings was then figured from the following formula:

$$\% \text{ Efficiency} = \frac{gpm \times head\ in\ feet}{bhp \times 3960}$$

By this procedure complete data were worked up on the pump for the different-size impellers operating at 1750 rpm. These data were first tabulated and the characteristic curves for one size impeller at a given speed were plotted, as in Fig. 2. From these curves for single sets of conditions or from the tabulated data, the curves Fig. 3 were plotted. The curves, Fig. 3, look rather complicated compared to Fig. 2, but a little study will show they are not.

In Fig. 2 the full-line curves have been plotted for an 8-in. impeller. At 500 gpm this pump is good for a head of 59 ft, at an efficiency of 80%. In Fig. 3 the head curve for the 8-in. impeller and the 80% efficiency curve cross practically on the 500-gpm line at *A*, corresponding to the values obtained from Fig. 2. This point is near the 10-hp curve, therefore, to operate the pump under the conditions given, a 10-hp motor will be required. Referring to Fig. 2, it will be seen that the pump when discharging 500 gpm requires about 9 hp to drive it.

At a 680-gpm discharge, Fig. 2, the pump also has an efficiency of 80%. At this point the pump requires over 10 hp to drive it. In Fig. 3 we find that the 80% efficiency curve and the 8-in. impeller-head curve cross at *B*, which corresponds to a 680-gpm discharge. This point is outside the 10-hp curve and shows that the pump will require over 10 hp to drive it. Unless the pump is to be operated continuously for long periods, or the surrounding air temperature is high, a 10-hp motor could probably do the job.

The characteristics of the 7.25-in. impeller are shown by the dotted curves, Fig. 2. This pump's best efficiency occurs at around 500 gpm and 44-ft head. In Fig. 3 we find that the 500-gpm line crosses the 7.25-in. impeller-head curve at 44-ft head, at *C* and the 80% efficiency curve approaches this point but does not cross it. At 400 gpm the pump is good for 48-ft head and a 77% efficiency, Fig. 2. Checking on Fig. 3, we find that the 400-gpm line crosses the head curve at *D*, which corresponds to 48 ft. This point is between the 75 and 78% efficiency curve, indicating about 77% efficiency.

This pump also operates at 78% efficiency at 575 gpm and a head of 38 ft, Fig. 2. We find this same point on Fig. 3 at *E*. All the points on the 7.25-hp impeller curve, Fig. 3, fall below the 7.5-hp line, therefore this pump can be driven by a 7.5-hp motor. The performance of the 6.5-in. and 5.75-in. impellers can be read off their respective curves, as explained for the larger impellers.

Impeller-Diameter Laws

The curves also check quite closely with the laws for impeller-diameters. For example, the capacity of a centrifugal pump varies as the impeller diameter, the head as the impeller diameter squared and the power required to drive the impeller as its diameter cubed. On the curves, Fig. 3, the 8-in. impeller is good for 500 gpm at 59-ft head. If the impeller-diameter is reduced to 7.25 in., its capacity will be reduced to $7.25 \times 500 \div 8 = 453$ gpm and its head to $7.25^2 \times 59 \div 8^2 = 48.5$ ft. Checking on Fig. 3, we find that at 450 gpm the 7.25-in. impeller is good for 47-ft head, which is very close to our calculations.

At 500 gpm and 59-ft head using an 8-in. impeller, about 9 hp is required to drive the pump. Then with the 7.25-in. impeller the power drops to $9 \times 7.25^3 \div 8^3 = 6.7$ hp. This is very close to the horsepower at 47-ft head and 450 gpm, a little more than half way from the 5-hp toward the 7.5-hp curve. It is therefore evident that if we do not have

a family of curves, Fig. 3, from which to read off what a pump will do under a given set of conditions we can easily calculate the performance if we have the simple characteristic curves shown in Fig. 2.

Assume we had the pump, Fig. 2, with an 8-in. impeller and wanted to use it to discharge 400 gpm at 35-ft head. If possible, we should maintain the best pump efficiency. At this point the pump is good for 600 gpm at 54-ft head and requires about 9.5 hp to drive it. For 35-ft head the impeller diameter will have to be reduced to $\sqrt{35 \times 8^2 \div 54} = 6.4$ in. This impeller will discharge $6.4^2 \times 600 \div 8^2 = 383$ gpm. Referring to Fig. 3, it will be seen that 383-gpm and 35-ft head lines intersect just below the 6.5 in. impeller curve.

If we wish to know the power required to drive the pump we can apply the law which says that power varies as the cube of impeller diameter. In this problem, horsepower equals $9.5 \times 6.4^3 \div 8^3 = 4.8$ hp, which is very close to the value obtained from Fig. 3. Here a 6.4-in. impeller curve would intersect the 383-gpm line slightly below the 5-hp curve. The capacity is a little below what we wanted, so to correct this, the impeller diameter can be increased to 6.5 in. Of course, we can calculate a series of values and plot the head-capacity curve for the new impeller diameter.

The 8-in. impeller could be used for the new conditions if its discharge is not too great. If the head were to remain constant at 35 ft this impeller would discharge 800 gpm, Figs. 2 and 3. At this point the efficiency would drop to 65% compared to 78 for the 6.5-in. impeller when discharging 400 gpm. Because of the increased flow, the head on the system will increase so that the 8-in. impeller probably will be operating around 45-ft head and a discharge of 700 gpm at an efficiency of 78%. The motor is, however, slightly overloaded, but if this causes serious overheating, the impeller diameter can be reduced about 0.25 in. to bring the load within the motor rating. Before making a change in a pump it is always advisable to check with the manufacturer. His advice will not cost you anything and a double check on any proposed change is good practice.

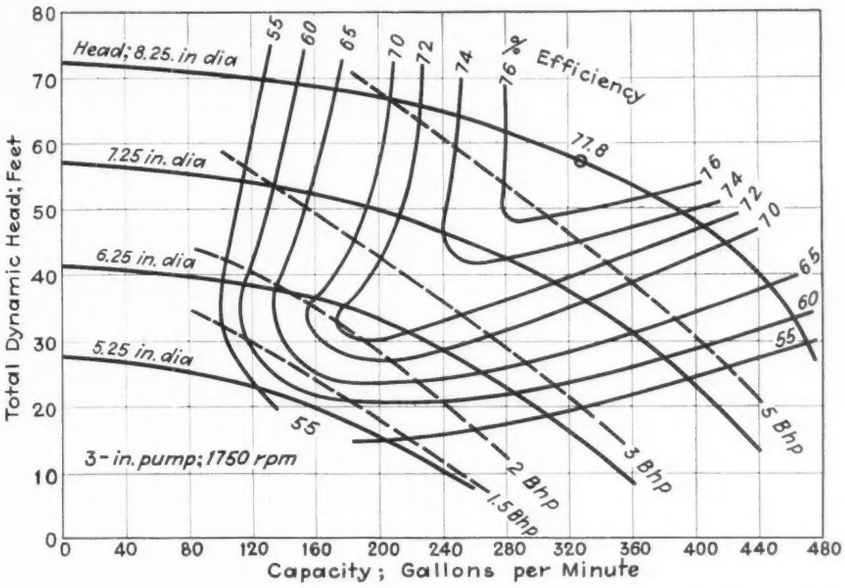


Fig. 6—Characteristic curves of a 3-in. centrifugal pump operating at 1750 rpm with four different impellers

When the pump was being tested to obtain the data from which the curves, Fig. 3, were plotted, the 8-in., 7.25-in. and 6.5-in. impellers were also tested at 1150 rpm. Data from these tests were used to plot the curves, Fig. 4. At 1150 rpm and best efficiency, the 8-in. impeller is good for 375 gpm and 25-ft head. Now let us see how the laws governing pump operation apply here. The capacity of a pump varies directly as impeller speed, the head as the speed squared and the power as the speed cubed.

At best efficiency the 8-in. impeller, Fig. 3, running 1750 rpm, will discharge about 600 gpm against a 54-ft head. Since discharge varies as the speed, at 1150 rpm this impeller will discharge at best efficiency about $1150 \times 600 \div 1750 = 394$ gpm. Head varies as the square of the speed then at 1150 rpm the head will be about $54 \times 1150^2 \div 1750^2 = 23.4$ ft. On Fig. 4, at 394 gpm the head is slightly more than 24 ft, which checks closely. Power to drive the pump varies as the cube of its speed. At 600 gpm and 1750 rpm the 8-in. impeller requires 10 hp to drive it. At 1150 rpm the power will decrease to $1150^3 \times 10 \div 1750^3 = 2.84$ hp, which again checks very closely with approximately 3 hp in Fig. 4 for 400 gpm and 24-ft head.

The curves Fig. 5 were obtained from test made with an 8-in. impeller operated at 1750, 1600, 1450, 1300 and 1150 rpm. These curves are used when deter-

(*Continued on page* 138)

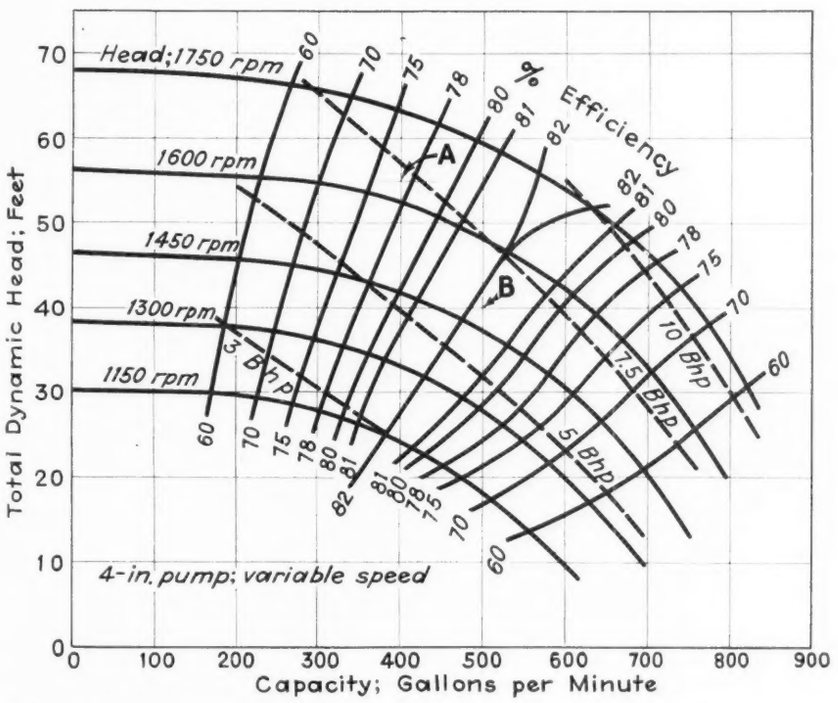


Fig. 5—Characteristic curves for a 4-in. centrifugal pump with 8 in. impeller operating at five different speeds

Disston Completes First Step in Power Program

New boiler house, designed for future high-pressure operation to permit expansion of generating facilities, completed in time to serve defense loads

By SAMUEL BLUM
Engineer, H M Wilson Co Engineers & Constructors Philadelphia

▶ SEVERAL WEEKS AGO, on the Henry Disston & Sons, Inc plant gounds in Philadelphia, high-ranking Army officers and OPM officials met with company officials in the presence of thousands of employees and guests, to mark completion of a new armor plant. At the same time a corner stone was laid and boiler drying-out fires lighted in the new high-pressure steam plant. The boiler plant had, however, been planned, and was well under way before the present national emergency developed.

The company has just celebrated its 100th anniversary, one century since the founder, Henry Disston, rented a cellar on Broad Street, near Arch and in sight of the Betsy Ross house and famous Christ Church. There, with no motive power, and with such steel as could be imported from abroad, he started an industry whose growth and progress parallels the growth of the nation itself. Today the name "Disston" is almost synonymous with "saw". The plant, 80 or more buildings clustered on 65 acres of Delaware River front, produces not only saws of every type and description, but also plastering trowels, files, and other tools requiring specially processed steel.

American Steel

In 1855, Henry Disston began to manufacture his own steel, the first crucible saw-steel ever made in America. Today, electric furnaces pour forth the tough metal required for high-grade tools, for armoring tanks, fighter planes, and for other ordnance uses as well.

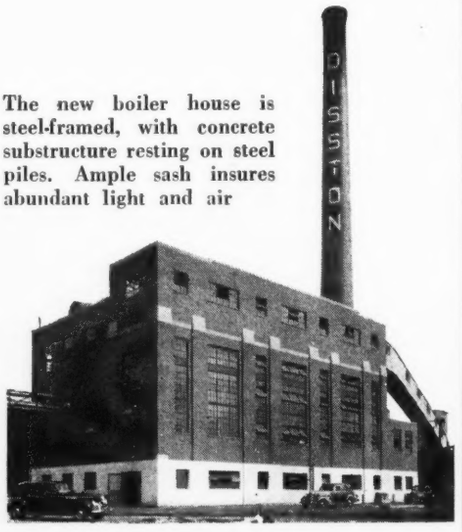
Before construction of the new boiler plant, steam, required primarily for operating numerous rolling-mill engines and heating, was supplied by 23 boilers, totalling 43,580 sq ft. These were housed in four structures scattered over the premises, each serving a group of buildings. The boilers, some dating back to 1896 and none more recent than 1910, comprised fire-tube and straight water-tube units ranging from 800 to 3800 sq ft, both hand and stoker fired. Low operating pressure (115 lb) and lack of superheat increased condensation losses in the long pipe lines. Other obvious losses included excessive radiation, blowdown, etc, incidental to firing so many small units at different locations.

These conditions, and the fact that a number of the boilers were subject to pressure reduction, prompted the management to proceed with development of plans for a new steam plant, including consideration of generating additional electricity.

Steam Needs

Steam requirements varied from 12,000 lb per hr during off periods in summer to average during working periods of from 129,000 lb per hr in summer to 167,000 lb per hr in winter. About 12 to 20% of this steam went direct to mixed-flow condensing turbines: three 750-kw, 0.6 pf, 1800-rpm, GE units, generating at 2300 v, 2 phase, 3 wire, and 60 cycles. These units, installed in 1912, received steam from various engine exhausts at about 2 lb, augmented by boiler steam at about 110 lb.

These machines produced approximately 35 to 40% of the total electric requirements; the company purchased the remainder from the Philadelphia Electric Co at 13,200 v, 3 phase, 3 wire, transformed to 2300 v, 2 phase, 3 wire, without paralleling. Current is delivered to the electric furnaces at full 13,200 v, each furnace having its individual transformer bank. Small motors operate on 220 v, 2 phase, 4 wire, received from 2300/220-v transformer banks located at convenient distribution centers.



The new boiler house is steel-framed, with concrete substructure resting on steel piles. Ample sash insures abundant light and air

Production directly influences current requirements. The average for five years during working periods came to about 2700 kw, with 4500 kw demand, 2500 of which was supplied by the power company. More recently, production required 3900 kw average with 5800 kw demand, 3800 being supplied by the power company.

Savings, beyond those to be realized from improved steam-plant conditions, could be made, therefore, only by reducing the amount of purchased current. Because this item links so closely with plant production, advisability of expenditure for generating equipment rests on prediction of future business.

Operating data and costs for five preceding years formed the basis for thorough studies of numerous alternatives. These were as follows:

1. *Install new low-pressure boilers in a central plant or in one of the present boiler houses, continue engine drives for mills, and continue to make and purchase current as at present.*

This plan represented the lowest initial investment, but precluded installa-

tion of additional generating capacity. Construction difficulties and restricted coal-storage and handling conditions decided in favor of a new location, rather than use of an existing boiler house.

2. *Install new low-pressure boilers for heating only, discontinue turbine operation, replace steam engines with electric mill drives, and purchase all current.*

This study showed the highest operating costs and, because of complete electrification, high investment cost.

3. *Install new 600-lb boilers with provision for future heat recovery, operate at 125 lb for the present, continue engine drives, and purchase and make current as at present.*

This scheme was selected. The initial investment here is increased only by the cost of the higher boiler pressure and the design provides the first step in a comprehensive program which could lead to ultimate electrification of drives, installation of generating equipment, and reduction to a minimum of current purchased.

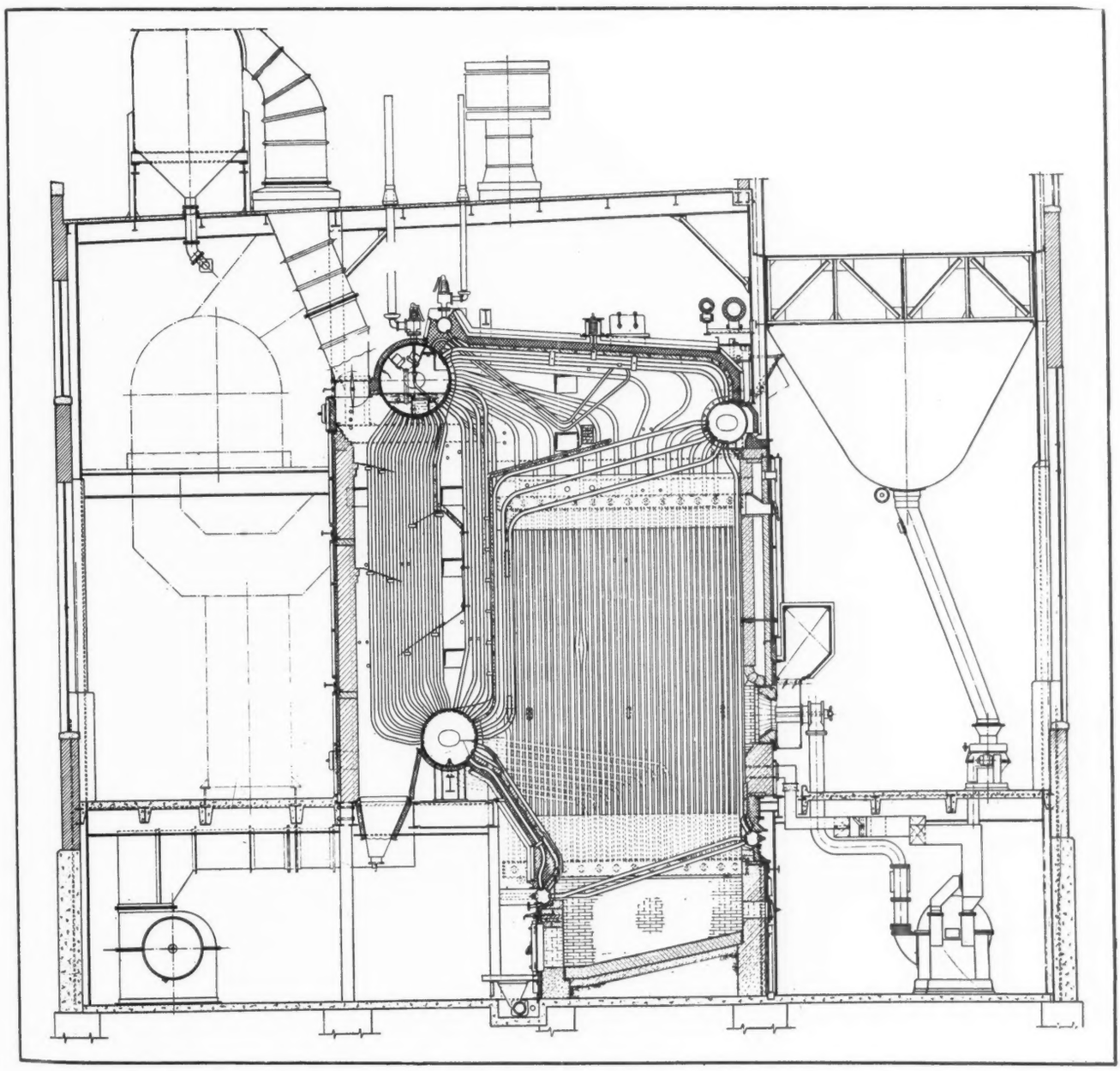
4. *Install new 600-lb boilers with full heat recovery, to operate at 600 lb, 150-F superheat. Install new topping condensing turbine to operate in parrallel with the power company, continue engine drives, and purchase minimum current.*

On the basis of continued high or even moderate production, this plan showed an appreciable return. Because of the uncertain conditions prevailing at the time, the initial part of the program (same as No. 3) and the high-pressure and generator phases were postponed, although every provision was made for them.

5. *Install new 600-lb boilers with full heat recovery, to operate at 600 lb, 150-F superheat. Install two bleeder condensing turbines, make all current (outside current purchased during down time only), and electrify drives.*

Electrification of drives required a considerable expenditure. Though a saving in maintenance would result, production would still be limited by the mills. It was considered expedient to retain the engine drives until the rolling mills had to be replaced.

The new boiler plant is located on



Cross-section shows boiler and water-cooled furnace, provision for future induced-draft fan, air heater, and dust collector

the river front. It has a steel frame with concrete substructure resting on concrete piles. The lower section is of concrete, the upper portion is brick with stone trim and the roof is precast lightweight concrete. The firing floor stands 13 ft above grade; grade level houses pulverizers, pumps, fans, and ash-handling facilities. Ample steel sash give maximum daylight illumination and ventilation. Space is provided around all equipment and the system of stairs and grating platforms provides easy access to all valves and parts requiring attention.

Of the three boilers, each rated at 75,000 lb per hr continuous and 85,000 lb per hr peak, two will carry the load, thus leaving one spare. Each unit contains about 11,000 sq ft of heating surface, including waterwalls. Design pressure is 600 lb, and all valves, fittings, and pipe are suitable for this pressure. At present, the units will operate at 125 lb, 428 F, but future installation of additional superheater elements and an air heater will permit operation at 575 lb and 608 F. The units are amply insulated; full steel casing insures freedom from leakage and keeps radiation loss to a minimum.

The wide range of load prompted choice of pulverized-fuel firing. In normal times, steam demands at the end of an operating period may drop as much as 100,000 lb per hr and it was felt that more efficient operation under such conditions could be obtained with powdered fuel.

Oil for Low Loads

During down periods, steam requirements may run as low as 12,000 lb per hr. For the manufacturing processes, the company stores and uses large quantities of light oil and it was felt that this fuel could be used efficiently during the low-load periods, if the furnaces were designed to handle it.

Furnaces are full water-cooled, with 4850 cu ft of volume; heat release will not exceed 23,000 Btu per cu ft per hr. The two forced-draft burners on each boiler toe in so the flames converge in the furnace. Each burner is provided with oil burners which can be used for lighting up or for operation at full range and capacity.

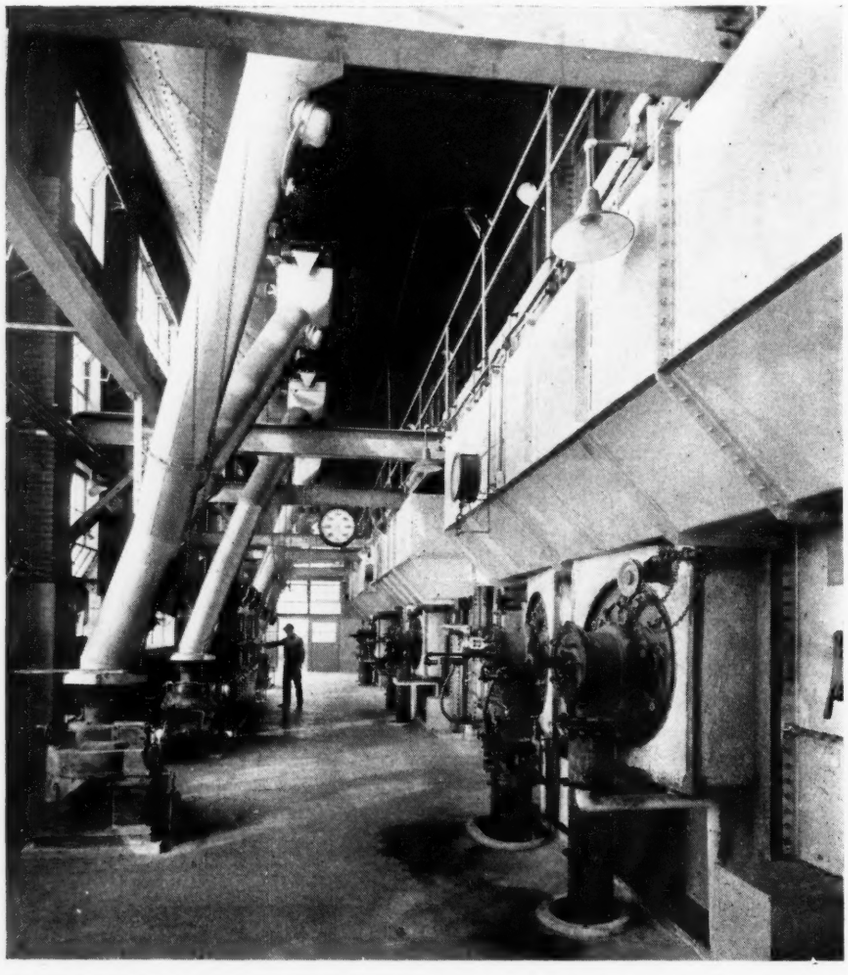
The four pulverizers, two No. 5 and two No. 4, are so connected and valved that each of the outside boilers is served by one of the larger mills to obtain full rating, or by one of the smaller mills to obtain partial rating. One or both smaller mills serve the middle boiler. Mills and piping are at grade, with the feeders at firing-floor level. Oil-pumping equipment, both electric and steam units, also stands at grade.

Coal is delivered by car, conveyed from track hopper to crusher, then elevated for dumping either to yard storage or to the suspended bunkers over the firing aisle. Coal from yard storage can be reclaimed at the boot of the elevator and conveyed to the bunker. Spouts provided with coal meters deliver the fuel to the feeders.

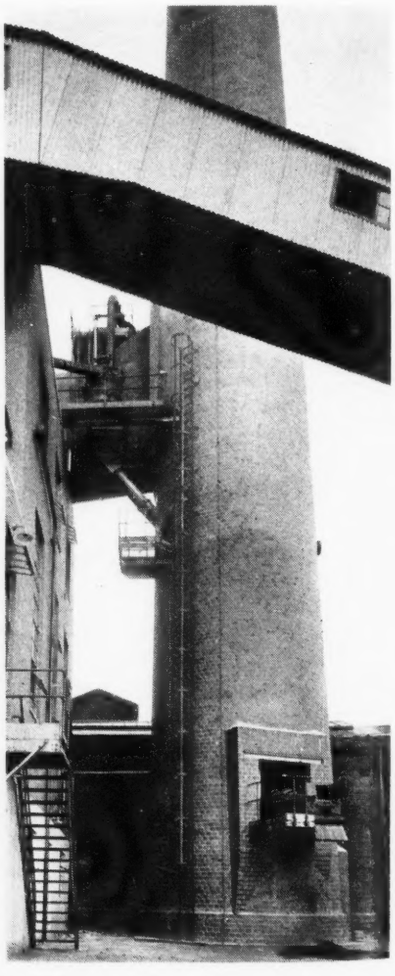
System capacity is 60 tons per hr. All machinery is under cover; convenient stairs and walks permit easy access and communication between all parts of the system in any weather.

A 12,000-gal underground tank provides sufficient oil storage for a full summer weekend.

A pneumatic system handles ash and



Boiler firing aisle features spaciousness and accessibility for operating convenience.



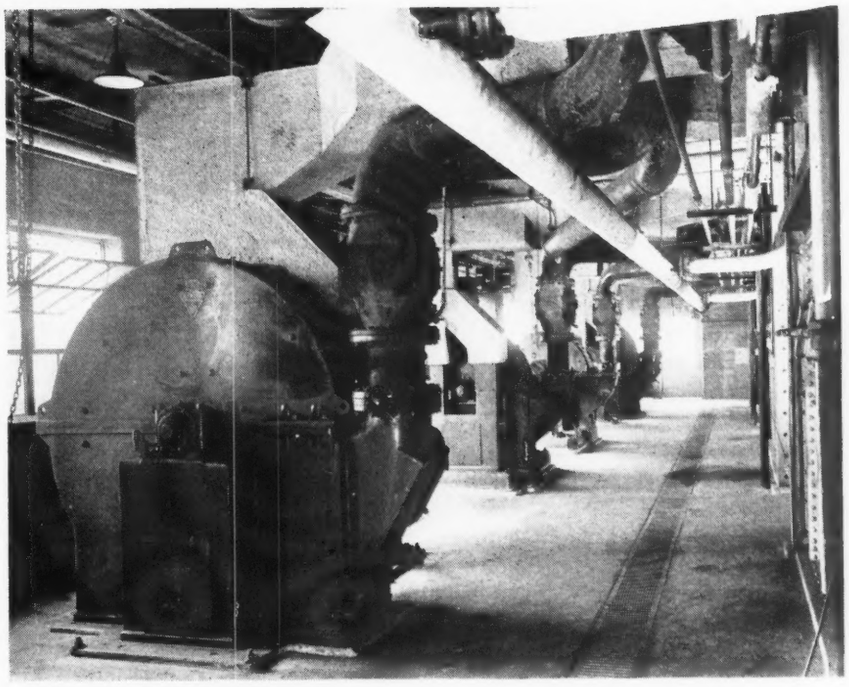
The lower part of the stack base, normally used only for support, serves as an ash-storage tank and houses the dustless unloader, with only spout protruding

soot accumulations. An ash pan with two intakes is provided at each boiler. There are also intakes at each of the boiler soot hoppers and at the breeching hoppers, with provision for picking up air-heater hoppers later. All intakes connect to a collector which is under intermittent suction produced by a steam-jet vacuum-producer. This operates under control of an electric timing valve and exhausts to the stack. During the short interval that the exhauster operates, the swing gate on the collector remains closed, accumulating material. When the vacuum is interrupted, the material drops to the storage tank, and the cycle repeats.

Material is handled and stored dry until ready to cart away. It then drops into the dustless unloader, a sort of modified concrete mixer. Here it is sprayed and mixed with water, emerging as a paste.

The radial brick chimney, 9 ft 6 in. dia and 220 ft high, will carry the plant on natural draft until air heaters are

(*Continued on page* 142)



The four pulverizers, two large and two small, are installed at grade level; piping interconnections permit maximum flexibility in adjusting capacity to boiler load

Principal New Power-Plant Equipment

Henry Disston & Sons, Inc, Tacony, Pa.

H M WILSON CO, ENGINEERS AND CONSTRUCTORS

Steam-Generating Equipment:

Boilers and water-cooled furnaces.....Riley Stoker Corp
Three 3-drum units; 75,000 lb per hr, continuous rating; 85,000 lb per hr for 8 hr; 125 lb, 428 F, present operation; 575 lb, 660 F, future operation; 8380 sq ft boiler surface; 2490 sq ft waterwalls; 13 ft 10½ in., furnace width (cc waterwall tubes), 15 ft, depth (front to back), 24 ft, mean height; 4850 cu ft, furnace volume; 23,000 Btu per cu ft per hr maximum heat release; alternate tubes in first boiler row omitted to form slag screen
Superheaters, 330 sq ft (660 sq ft future).....Riley Stoker Corp
Air heaters, future, 7200 sq ft.....Riley Stoker Corp

Boiler Auxiliary Equipment:

Pulverizers, 2, No. 5.....Riley Stoker Corp
Pulverizer motors, 2, 100 hp, 880 rpm..Westinghouse Elec & Mfg Co
Pulverizers, 2, No. 4.....Riley Stoker Corp
Pulverizer motors, 2, 60 hp, 1150 rpm..Westinghouse Elec & Mfg Co
Burners, 2 per blr, horizontal-flare.....Riley Stoker Corp
Oil-burning equipment.....Faber Engrg Co, Schutte & Koerting Co
Forced-draft fans, 3, vortex control.....Clarage Fan Co
32,000 cfm at 1165 rpm, 7.5 in. sp, 55 bhp; 32,000 cfm at 875 rpm, 4.0 in. sp, 28 bhp; 25,000 cfm at 690 rpm, 2.0 in. sp, 12 bhp
Fan motors, 2, 30/19 hp, 875/690 rpm..Westinghouse Elect & Mfg Co
Fan turbine, 1, single-stage.....Moore Steam Turbine Div
Throttle, 125 lb, 403 F; backpressure, 5 lb g; integral helical reduction gear; hydraulic direct-acting oil-pump governor, 3–1 range
Breeching, air ducts.....Connery Construction Co
Stack, radial brick.....Alphons Custodis Chimney Construction Co
Height above base, 220 ft; internal diameter, top, 9 ft 6 in.
Soot blowers, 6 per blr.....Vulcan Soot Blower Corp
2-element, automatic valve-in-head
Gage glasses, remote-reading.....Reliance Gage Column Co
Combustion control.....Leeds & Northrup Co

Fuel- and Ash-Handling Equipment:

Coal-handling system, 60 tons per hr capacity.....Jeffrey Mfg Co
Track hopper, apron feeder, single-roll 24x36-in. crusher, continuous bucket elevator, belt conveyor, and flight conveyor
Coal bunker, suspension.....Belmont Iron Works
Coal-bunker lining, bitumastic.....Wailes Dove-Hermiston Corp
Oil pump, 7x3½x6-in. duplex piston.....Wagener Steam Pump Co
Oil pump, motor-driven gear unit.....Schutte & Koerting Co
Oil strainer.....Strong, Carlisle & Hammond Co
Ash-handling system, pneumatic.....United Conveyor Corp
Rotary dustless unloader; ash-storage tank built into stack base

Feedwater System:

Deaerating hot-process softener.....Cochrane Corp
One sedimentation tank, 12 ft 6 in. dia by 24 ft high; two softener filters, 8 ft dia
Condensate oil-removal system.....Cochrane Corp
Continuous blowdown system.....Cochrane Corp
Boiler-feed pump, 1.....Worthington Pump & Machinery Corp
Two-stage centrifugal, 450 gpm, 510 ft TDH (220-F water), 3500 rpm
Feedpump turbine, 1, single-stage.....Moore Steam Turbine Div
Throttle, 125 lb, sat.; backpressure, 5 lb g; 100 hp, 3500 rpm
Boiler-feed pump, 1.....Worthington Pump & Machinery Corp
Two-stage centrifugal, 220 gpm, 483 ft TDH (220-F water), 3500 rpm
Feedpump motor, 1, 3500 rpm, 50 hp....Westinghouse Elec & Mfg Co
Condensate pumps, 2, single-stage.....Fairbanks, Morse & Co
60 gpm, 120 ft TDH, driven by 5-hp, 3600-rpm Westinghouse motor
Backwash pump, 1, single-stage.....Fairbanks, Morse & Co
600 gpm, 50 ft TDH, driven by 10-hp, 1800-rpm Westinghouse motor
Feedwater regulators, 3, 3-in. Copes.....Northern Equipment Co

Meters and Instruments:

Draft gages, 3, multi-pointer.....Hays Corp
Temperature recorders, 3, 6-pt potentiometer..Leeds & Northrup Co
CO_2 Recorders.....Leeds & Northrup Co
Pressure recorder, 1, two-pen.....Bristol Co
Master steam gage.....Manning, Maxwell & Moore, Inc
Flow meters.....Republic Flow Meters Co
Oil-tank-level gage, 1, high, low-level alarms.....Liquidometer Corp
Oil meters.....Niagara Meter Co
Coal meters, 4, to register flow in 16-in. pipe.....Bailey Meter Co
Smoke indicators.....Ess Instrument Co
Gage board, completely assembled.....Leeds & Northrup Co

Piping, Valves, and Miscellaneous Equipment:

Fabricated pipe.....McArdle & Cooney Inc
Piping contractor.....Nelson Co
Pipe and Equipment Insulation.....Ehret Magnesia Mfg Co
Insulation contractor.....Philadelphia Asbestos Co
Valves.....Lunkenheimer Co
Non-return valves.....Schutte & Koerting Co
Reducing valves.....Schade Valve Mfg Co
Float-valve assemblies.....H Belfield Co
Water strainer, 6-in, twin, 400 gpm capacity.....Elliott Co
Sump pump, 100 gpm, 65 ft TDH.....Labour Co
Sump-pump motor, 5 hp, 1750 rpm.....Allis-Chalmers Mfg Co
Sump syphon.....Schutte & Koerting Co
Blowdown tank.....Downington Iron Works
Miscellaneous tanks.....Hilyard Co

Electrical Equipment:

Distribution equipment.....Westinghouse Elec & Mfg Co
Four 100-kva transformers, 2400-v primary, 240/120-v secondary; one 3-kw motor-generator set
Switchboard, 8-panel, dead-front, steel..Westinghouse Elect & Mfg Co
Electrical contractor.....Ross Electrical Construction Co

Guide to Better Compressor Lubrication

James I Clower, Assoc Professor of Machine Design, VPI, and well-known lubrication authority, tells how to select oils and greases for bearings and internal parts of rotary and centrifugal compressors, and how to apply lubrication for best results

►LUBRICATION of rotary and centrifugal air compressors is generally much simpler than that of reciprocating compressors. There are fewer moving parts and because of their shape and the higher speeds, these are better adapted to the formation and maintenance of oil films. Moreover, pressure and temperature conditions are usually less severe than they are in reciprocating compressors.

Rotary compressors comprise a group of small-capacity machines designed generally for discharge pressures less than 125 lb. They are driven directly, usually by high-speed electric motors. In general, they have only one or two rotating parts fitted closely within a circular or partly circular housing. Variations in design details of these compressors are many, however, two common designs being the sliding-vane type, Fig. 3, and the 2-lobe type, Fig. 5.

Lubrication Points

The only parts of these compressors that require lubrication are the bearings, impeller or rotor, and, where provided, timing gears. Bearings may be of the ball, roller or sleeve type. Some vane-type machines are so constructed that the vanes make contact with the housing; in others a clearance of a few thousandths of an inch is provided. In the first type, oil acts as a lubricant and seal, while in the second type it acts as a seal only, to prevent blow-by or loss of compression. Although bearing and timing-gear loads are moderate, they are variable and depend on the angular impeller position.

Internal lubrication is generally supplied by means of manually or automatically controlled sight-feed oilers (Fig. 3), mechanical force-feed lubricators (Fig. 2), grease cups, or grease-gun fittings (Fig. 5). Bearings and other external parts may be equipped with drop-feed oilers (Fig. 3), wick-feed and ring oilers (Fig. 5), a force-feed circulation oiling system (Fig. 6), or grease-gun fittings.

One design of an air-operated drop-feed oiler is shown in Fig. 4. This oiler has a needle valve V at the bottom of the oil cup, with a stem extended through the operating cylinder on top of the cup. Upon starting the compressor, pressure from the discharge side is exerted on the bottom of the cup-leather piston P, moving it up and lifting valve V from its seat, thus permitting oil to feed by gravity into the compressor and its bearings. When the compressor is shut down, the spring on top of the piston closes valve V, stopping the oil feed. The rate of feed is controlled by turning knurled nut N at the top of the stem. Nut N can be used, also, to open valve V by hand in case the compressor is operated without pressure on the discharge. A minimum of

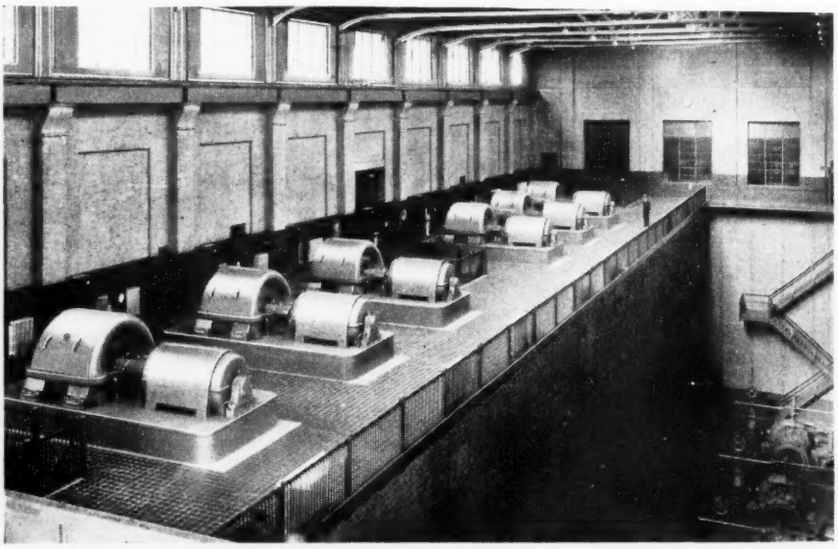


Fig. 1—Six 42,500-cfm turbo-blowers, driven by 2000-hp motors, supply air at 7.5 lb pressure, in a sewage-disposal plant

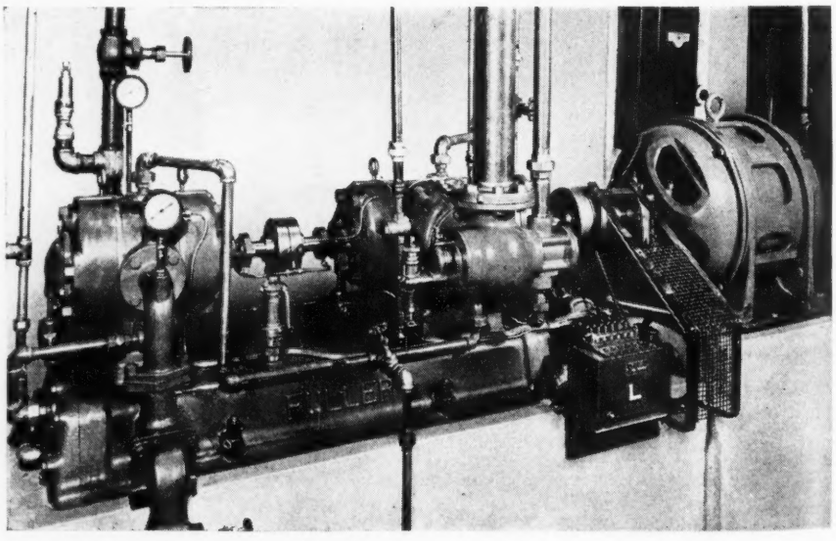


Fig. 2—Motor-driven sliding-vane compressor internally lubricated by multiple-feed mechanical force-feed lubricator at L

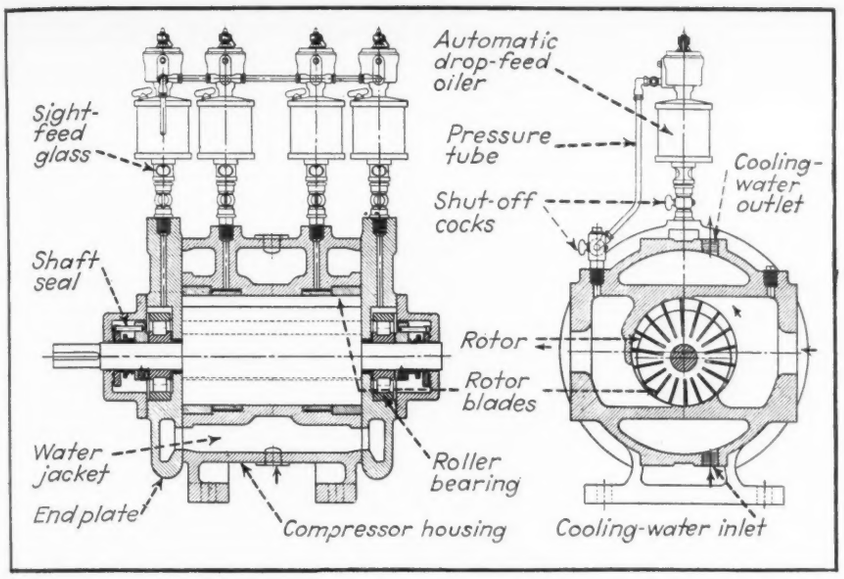


Fig. 3—Sliding-vane compressor lubricated with drop-feed oilers

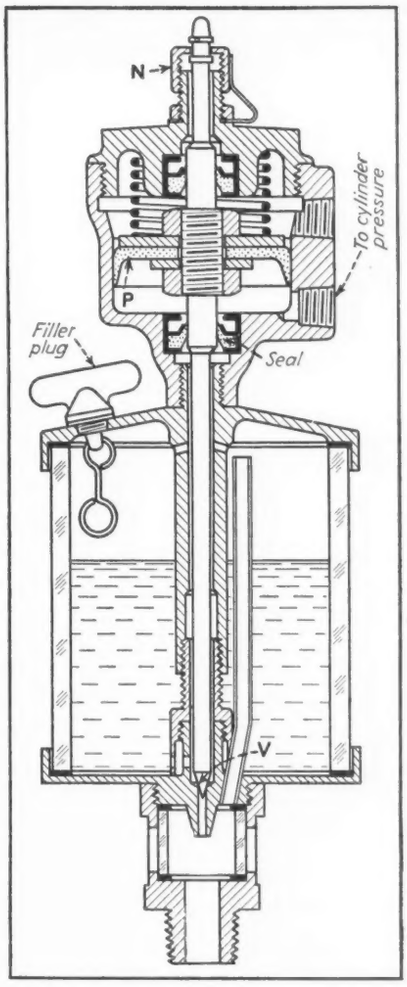


Fig. 4—Automatic air-pressure-operated drop-feed oiler

5 lb pressure is required to operate this oiler satisfactorily.

Another automatic oiler similar to that shown in Fig. 3, but electrically operated, is also available. It has a solenoid coil mounted on a steel plunger enclosed in a cast-iron housing. When coil is energized, the plunger is lifted from its seat, permitting oil to flow out of the cup into the compressor in the same manner as the air-operated oiler. When the current is cut off, that is, when the motor driving the compressor is stopped, the plunger falls by gravity to its seat, stopping the oil feed. Models are available having from 1 to 12 feeds, and reservoir capacities of 1 pt, and 1, 2, and 4 qt.

Centrifugal compressors are usually classified as turbo-blowers and turbo-compressors. Arbitrarily, turbo-blowers are units having a discharge pressure of 40 lb or less, whereas turbo-compressors are those having discharge pressures in excess of 40 lb. Either type may be water-cooled or not depending on pressure and operating speed. They are usually driven by a direct-connected electric motor or steam turbine. In some cases, however, they are driven through speed-increasing gears by steam or internal-combustion engines. They are seldom operated at less than 1200 rpm, sometimes as high as 20,000 rpm. They are essentially large-volume units, being available in capacities ranging from 1000 to 100,000 cu ft of free air per minute. They are built in a number of stages, the number varying from 1 in small, low-pressure units, to as many as 28 in large, high-pressure machines.

As shown in Figs. 7 and 8, there are no internal rubbing surfaces and hence centrifugal compressors do not require any internal lubrication. These compressors look very much like a centrifugal pump internally. The bearings are the only parts that require lubrication. Small- and medium-size units generally have ring-oiled bearings, Fig. 7, whereas force-circulation oiling is generally used on the larger machines, Fig. 8. Steam-turbine-driven units are fre-

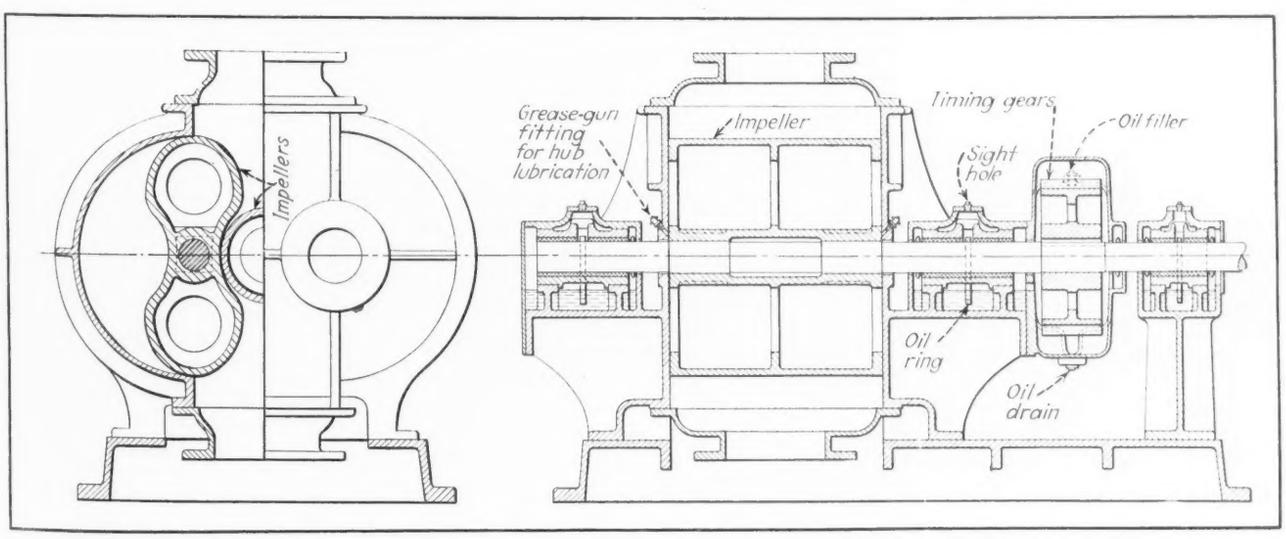


Fig. 5—Two-lobe rotary compressor with ring-oiled bearings and pressure-grease-lubricated internal clearances

quently served by the same oiling system that serves the turbine.

Successful compressor lubrication depends both on the use of the proper lubricant and on its correct application. Poor-quality lubricants or improper use of correct lubricants will generally lead to difficulty, inefficient operation and, sometimes, costly shutdowns.

Unlike internal-combustion engines, the lubricant fed into the cylinder of a rotary compressor is not burned, and, if of high quality, the amount evaporated is nil. Consequently, only a small quantity is required to maintain an effective lubricating and sealing film on the interior surfaces. Troubles caused by insufficient lubricant are seldom encountered.

The most reliable method of deter-

(*Continued on page* 148)

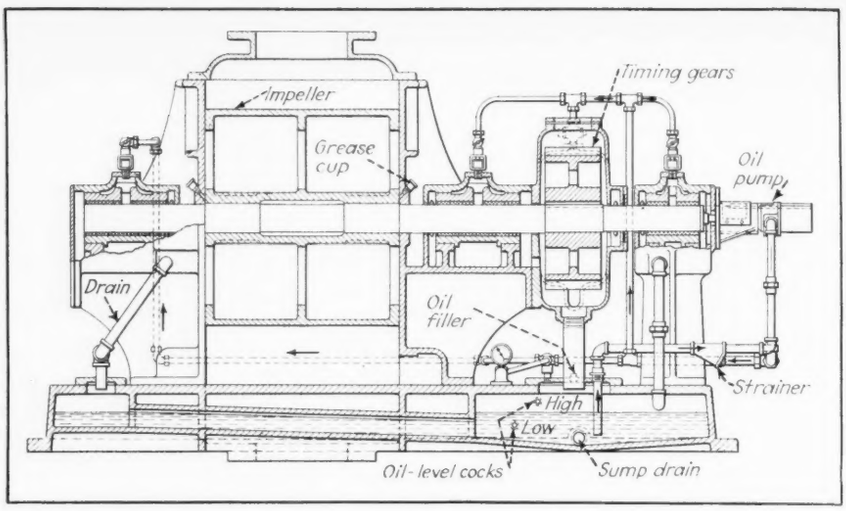


Fig. 6—Two-lobe rotary compressor with bearings lubricated by oil-circulation system, and grease-cup-lubricated internal parts

GUIDE TO LUBRICANT SELECTION FOR ROTARY COMPRESSORS

Compressor Type	*Method of Application*	*Size, Hp*	*Flash Point, F*	*Fire Point, F*	*Viscosity, Saybolt* 100 F	130 F	210 F
Rotary-sliding vane	Any	Any	385	440	320	143	50
Rotary-lobe gear	Circulation, splash	25 and under	400	455	535	210	56
Rotary-lobe gear	Circulation, splash	Over 25	415	465	650	266	65
Centrifugal	Circulation, ring	Any	385	440	150	85	42
Rotary-lobe gear, vane	Grease gun, grease cup	Any	High quality lime-base grease of smooth texture, containing 10 to 20% soap of either No. 2 or 3 consistency. No. 2 is generally better for gun application that No. 3				

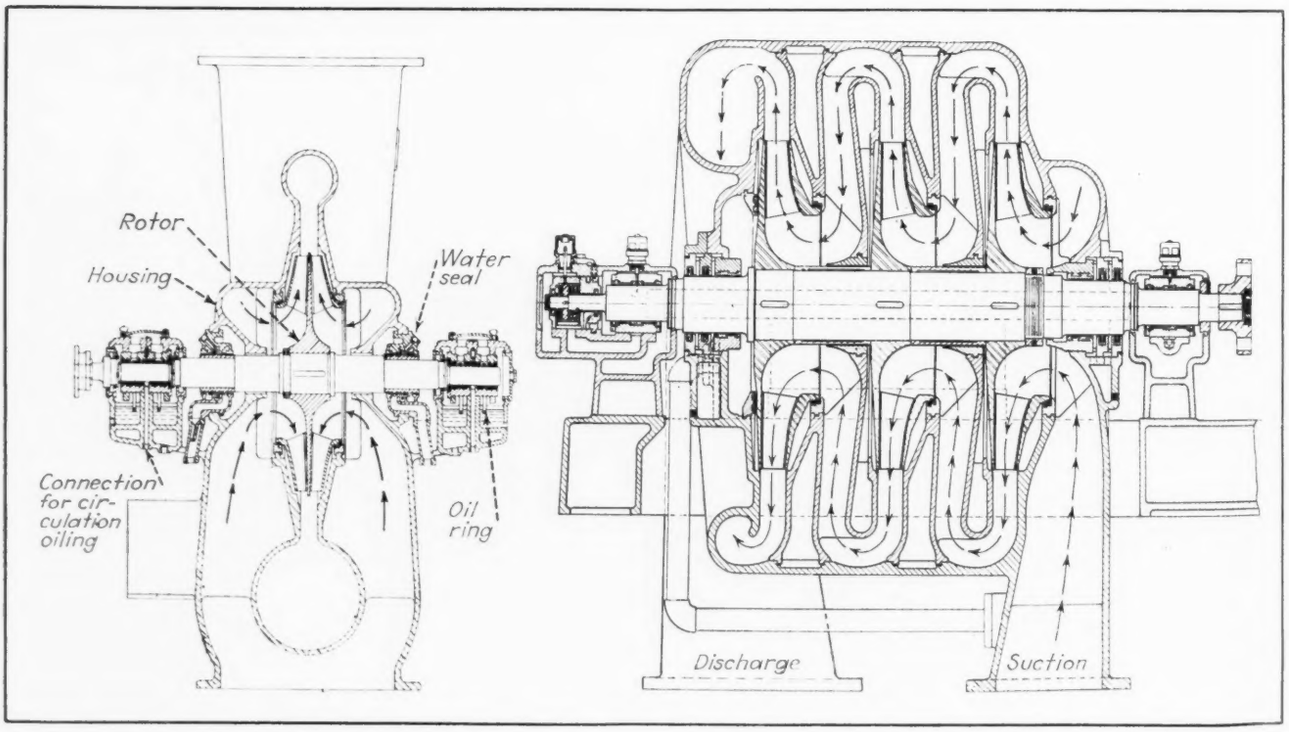


Fig. 7—Single-stage, double-flow, centrifugal compressor has ring-oiled bearings and water seals. Fig. 8—Three-stage turbo-compressor (right), lubricated by circulating oil system

DEFENSE DIGEST

Trends, troubles, achievements, shortcomings, gossip and sidelights of the National Defense Program, with particular reference to industry's job of production, in which the power engineer is a key man

Shortages of many materials have become acute, as predicted. Everywhere you hear manufacturers (particularly those engaged in non-defense work) complaining of the difficulties of getting steel, zinc, aluminum, copper, brass, tungsten, and so on—mostly metals, but with other materials increasingly in the picture.

Priorities have become almost a matter of life and death to some industrials. If they can't prove a close relation to defense, or some other basic public need, many will be forced to restrict operations, except as they can find substitutes for strategic materials formerly used.

Is the shortage real or artificial? There *is* a shortage of many metals in the sense that you can't just go out and get them when you want them, but this doesn't mean that the metals that have "disappeared" have actually been *consumed* in manufacturing. The simple fact is a lot of hoarding is going on—hoarding of a more or less "legitimate" and "natural" character. The Army and Navy, as well as industry, have been acting like the housewife who hears that sugar is scarce; she plays safe and lays in a supply. A plant-to-plant canvass would reveal thousands of small industrial stock piles of aluminum, copper, brass, etc. all over the country—not for speculative resale, but for protection against future production needs.

OPM has asked American industry to help it find out what quantities of strategic metals are really needed and where they are. The Census Bureau has been mailing out 65,000 questionnaires on the manufacturing uses of defense metals. Recipients are asked to report the stocks and use (during August) of antimony, cadmium, chromium, cobalt, copper, ferro-alloys, iridium, lead, manganese or spiegeleisen, mercury, molybdenum, non-ferrous alloys, tin, vanadium, tungsten, zinc, and scrap metals containing any of these. Results will be tabulated in Washington on the punch-card machines in the Bureau of Census and used directly for adminisrtative checkup of priorities by OPM.

Subcontracting is still a major problem. For months the government has been urging prime defense contractors to spread the work by sub-letting "bits and pieces" of the jobs. Progress has been slow, partly because most of the prime contractors wished to keep

the work in their own shops, and partly because many of the small manufacturers didn't want to "meddle with government business." This last view had force as long as they had plenty of orders for peace-time goods and could get the necessary materials, but now that some of these plants must restrict normal operations for lack of essential metals, there is a new and urgent reason to seek defense work—there is no other way to insure priorities for materials needed to keep the plant going. Labor, too, is strongly behind this movement, to avoid extensive unemployment in non-defense plants. Thus all factors are now pushing for more extensive sub-contracting. Even the Army and the Navy, which have been somewhat luke-warm, are now on the subcontracting bandwagon to speed up production.

Plane Building is now a major industry. Over 150,000 men in the United States are now making airplanes; 35,000 are at work on motors, 8,000 on propellers. Tanks are another big in-

dustry in the making. The new Army program calls for an output of 1,000 medium tanks per month by July, 1942. This tank program will presumably be handled by present contractors—Chrysler, American Locomotive, and Baldwin.

Ordnance Plants in appreciable numbers are now getting into operation. Of the new plants, a checkup shows that two powder plants, one TNT plant, seven shell-loading plants, one toluol plant, one armor-plate plant, one armor-piercing-core plant and three small-arms ammunition plants are in operation. Even at that, most of the new ordnance factories will not get going until the early spring of 1942.

Machine Tools approximating $10,000,000 are being sent to the USSR to help Russia make munitions to continue the fight against Germany. China, too, will get tools from the United States. Yet these two together are only a drop in the bucket; the American machine-tool output for 1941 will probably surpass $750,000,000.

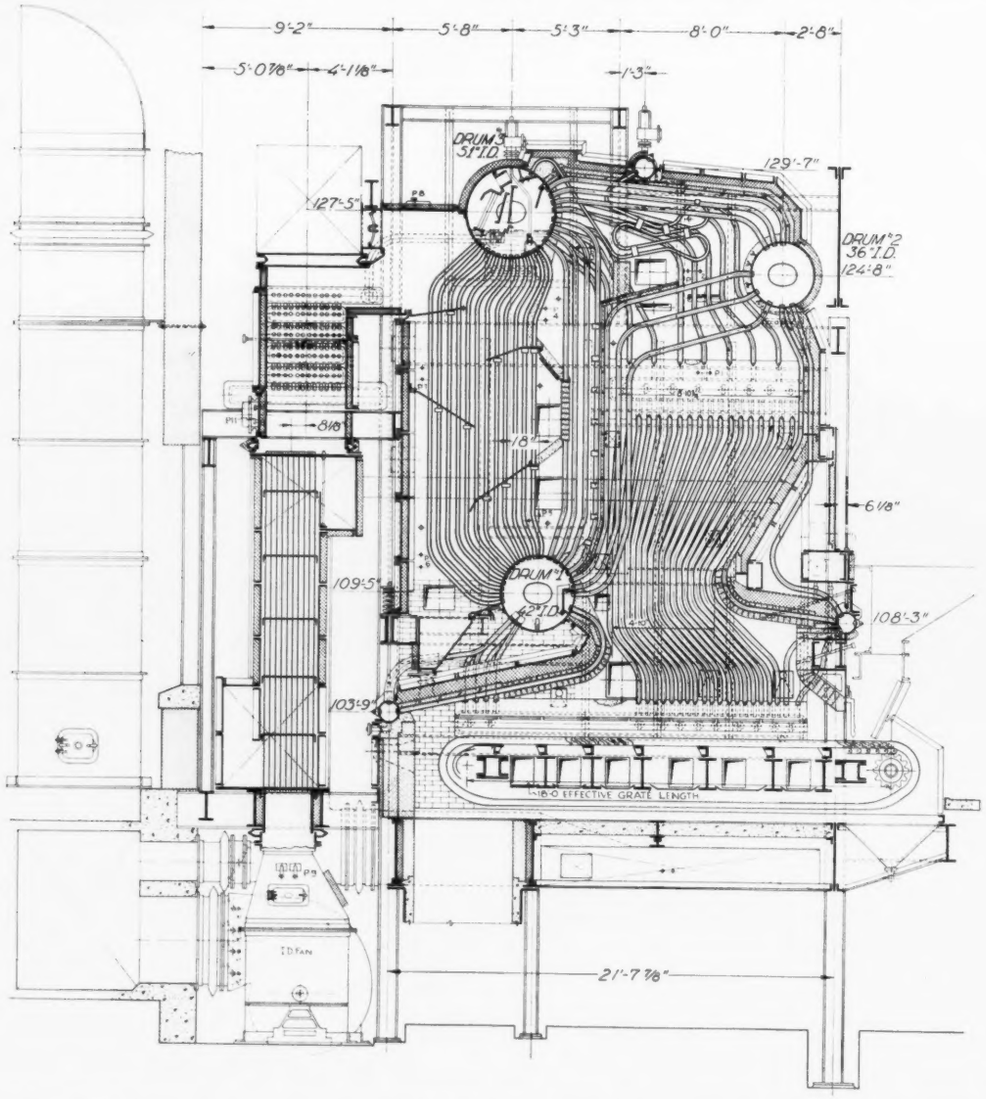
Trucks (over one million of them) will be needed by our military forces—in addition to the large number produced for the Army in the last year. Military trucks are of special design and harder to build than regular commercial vehicles.

National Income has been rising rapidly, and will average about $90,000,000,000 for the last half of 1941. A further increase to a $95,000,000,000 or $97,000,000,000 rate may be expected.

. . . *out where the corn grows tall*

however this Harrington Stoker Fired Riley Unit

Because of low B.T.U. content, high ash, high sulphur, low fusion temperature and low grindability of Iowa coals, the economical and satisfactory utilization of these coals presents quite a problem. The outstanding and completely satisfactory performance of the Harrington Stoker Fired Riley Steam Generating Unit recently installed by the Iowa State College of Agriculture and Mechanical Arts, Ames, Iowa, clearly indicates that this type of unit and this method of firing affords the best means of successfully handling these low grade coals.



IOWA STATE COLLEGE OF AGRICULTURE AND MECHANICAL ARTS, Ames, Iowa
100,000 lbs. per hour Harrington Stoker Fired Riley Unit consisting of Riley boiler, superheater, water-cooled furnace and arches, economizer and air heater

RILEY

STOKER CORPORATION, WORCESTER, MASS.

Boston New York Philadelphia Pittsburgh Buffalo Cleveland Detroit Seattle Baltimore Richmond Denver
St. Louis Cincinnati Houston Chicago St. Paul Kansas City Los Angeles Atlanta Memphis New Orleans

It will pay you to visit modern Riley Installations

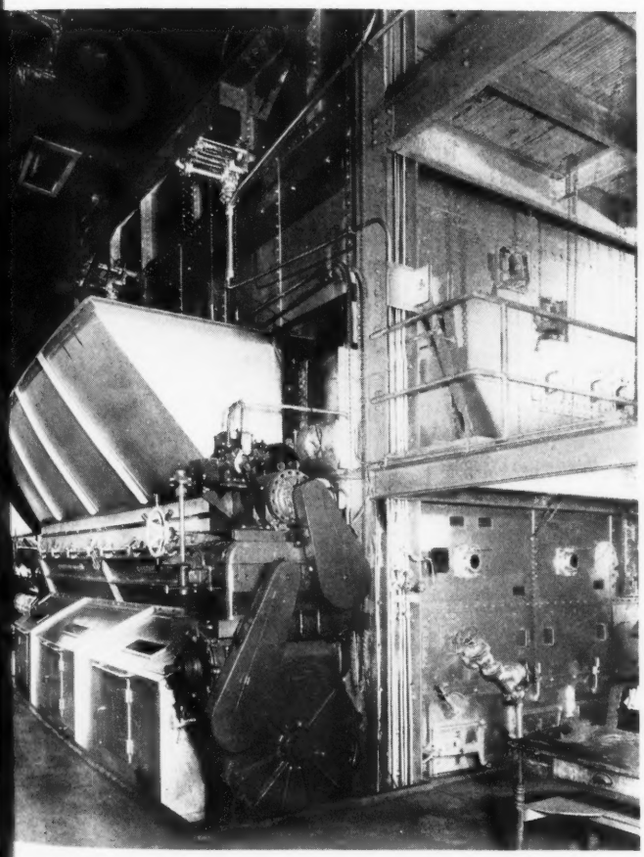
the coal is not so very good . . .

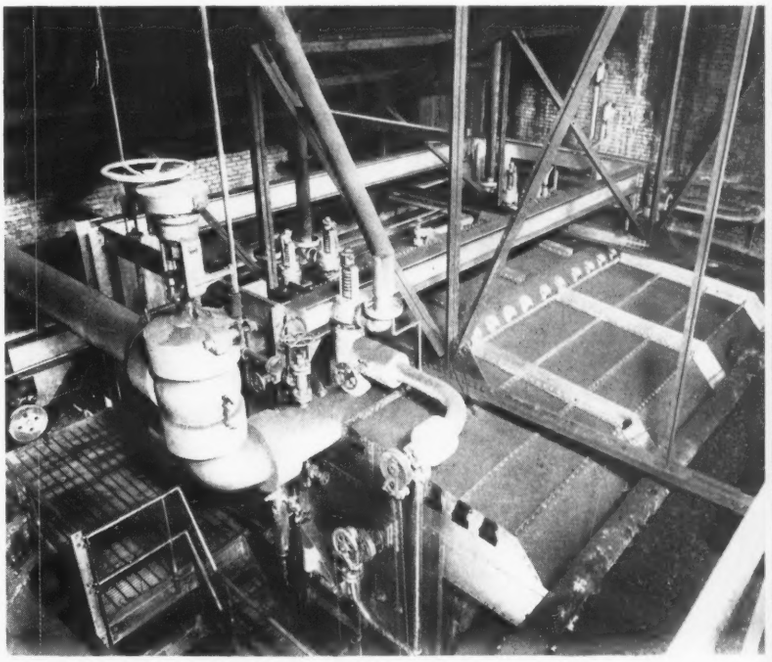
burns it at 85.48% efficiency without difficulties

owa State College recently installed a 100,000 bs./hr. Harrington Stoker Fired Riley Steam enerating Unit designed to burn low grade owa coals. The unusual success of this in-tallation is manifest not only from the study f the excellent results being obtained from the unit as indicated by test results below, but also by the fact that only two weeks after the installation was started up acceptance tests were conducted, guarantees of efficiency and capacity were exceeded and the unit accepted as entirely satisfactory.

Heat absorbed by water in economizer	224.12
" " " " and steam in boiler	6834.17
" " " steam in superheater	303.25
" " " steam generating unit	7361.54
Total heat per lb. of coal as fired	8612.
Ave. efficiency during 21-hour test	85.48%
Guaranteed efficiency	83.7%

Moisture	19.17
Ash	18.80
B.T.U./lb.	8612
Volatile	25.90
Fixed Carbon	36.13
Sulphur	4.97
Nitrogen	0.68
Carbon	47.66
Hydrogen	3.45
Oxygen	5.26





A survey of your power plant by a consulting engineer will possibly show ways of making surprisingly large savings in power costs

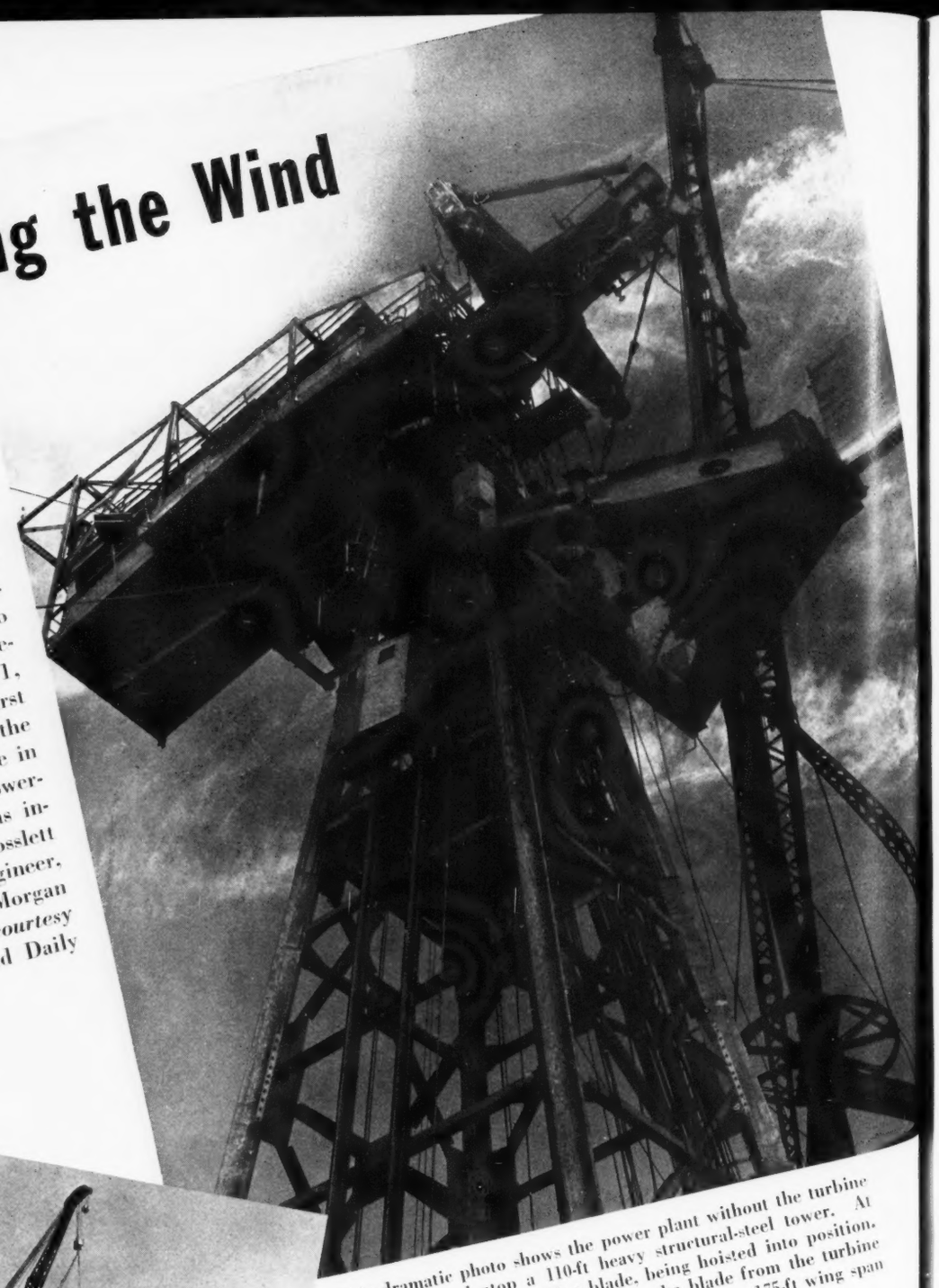
COMPLETE STEAM GENERATING UNITS

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS • AIR-HEATERS
ECONOMIZERS • WATER-COOLED FURNACES • STEEL-CLAD INSULATED SETTINGS • FLUE GAS SCRUBBERS

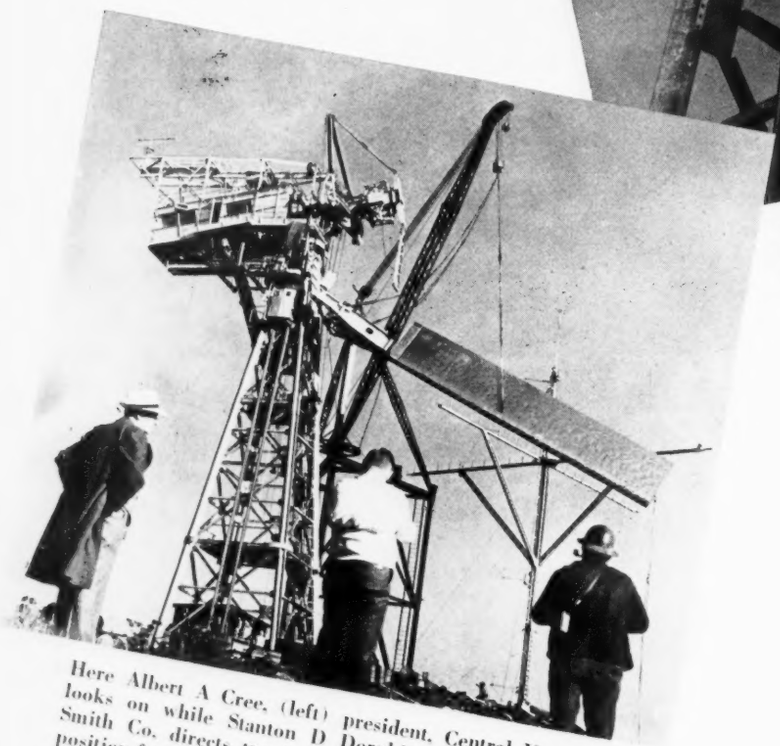
before purchasing Boiler or Fuel Burning Equipment

Harnessing the Wind

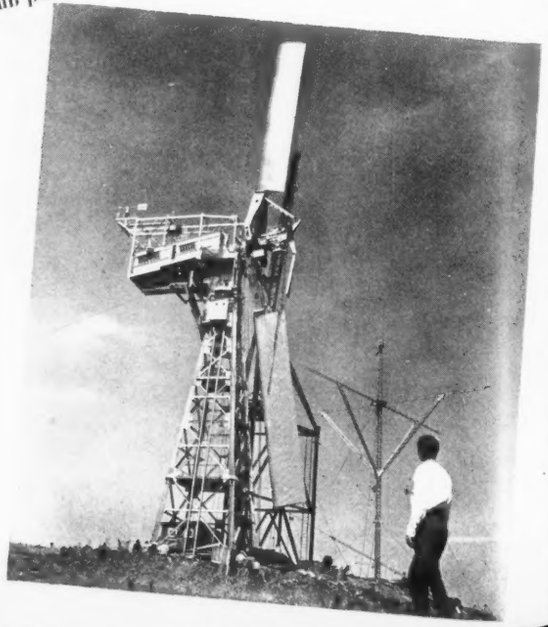
▶ AFTER MANY MONTHS of research, designing, manufacturing and constructing, the world-famous 1000-kw wind turbine power plant at Grandpa's Knob, near Rutland, Vt., is about ready to go into service. This plant, described in June, 1941, POWER (page 56) is the first wind-power plant in the world designed to operate in parallel with other power-generating units. It was invented by Palmer Cosslett Putnam, a Boston engineer, and built by the S Morgan Smith Co. (*Photos courtesy Donald Guy*, Rutland Daily Herald.)



This dramatic photo shows the power plant without the turbine vanes, mounted atop a 110-ft heavy structural-steel tower. At the right is the first turbine blade, being hoisted into position. Note the heavy A-frame to support the blade from the turbine shaft hub post. Together the two blades have a 175-ft wing span



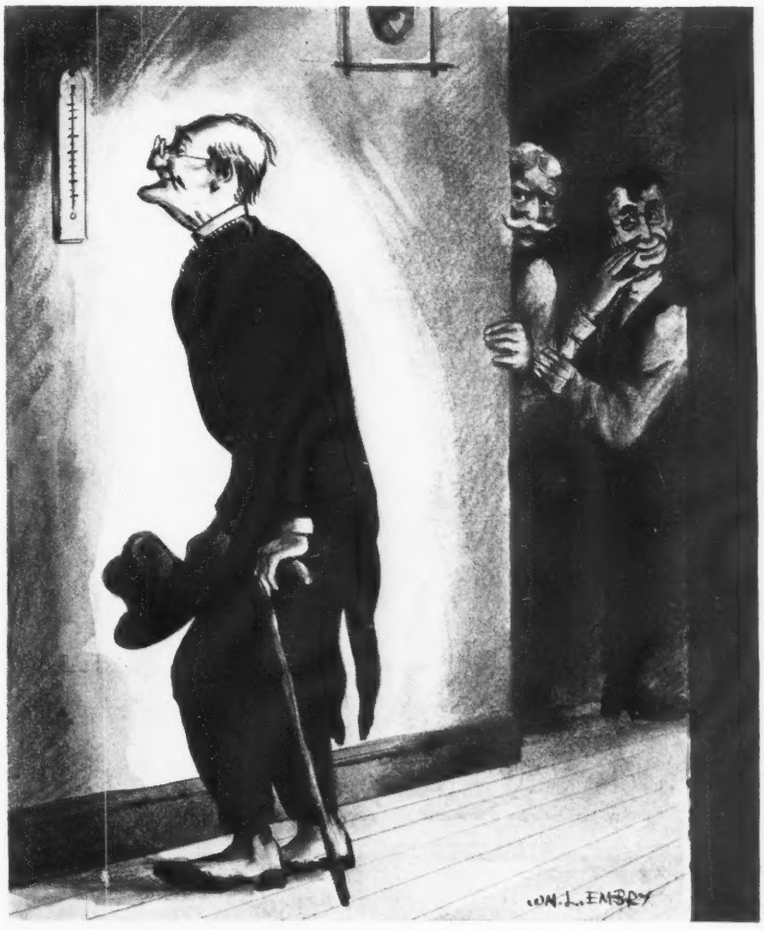
Here Albert A Cree, (left) president, Central Vermont Public Service Corp. looks on while Stanton D Dornbirer (right) erection engineer, S Morgan Smith Co, directs turning of first turbine blade from horizontal to vertical position for connection to turbine-shaft hub post. First blade has been installed (see photo at right) and the inventor watches the second blade being hoisted into position, completing the construction of his brain-child



THE OLD CHIEF

XI—Tricks of the Trade

Eleventh in a series by William Doran, chief engineer, Essex County Sanatorium, Windsor, Ontario. Writing of the inspiration of the past, he has captured much of the human side of engineering that lies beneath the maze of power-plant costs and the wavy lines on paper disks



. . . adjusted his glasses and read the thermometer in the entrance hall

▶A MAN with such a profound knowledge of human nature, as had the Old Chief, could not fail to understand the importance of not offending his fellow employees, no matter how high or how low their status in the organization might be. The good will and harmony of the whole plant was more important to him than the fleeting pleasure some people derive from telling misguided persons how ignorant and dumb they really are.

I remember a factory hand who complained that a fault in the product was due to lack of heat in the steam-cored rolls and that the thermometer was "all wet." A careful check proved that this was not true, but the Old Chief did not "jump on" the man; he merely ordered that the trap be changed and a new thermometer installed. On another occasion a man claimed that his machine was running below speed. A speedometer proved that this was not so, but again the Chief ignored the findings and ordered the motor changed. "It's due for an overhaul, anyhow," he said.

When the maintenance man reported that the high cost of servicing the hot-water faucets was due to "gol-darn" negligence of the employees in failing to shut them off tight, the Old Chief was against posting notices to remedy the trouble. Instead he ordered the faucets replaced with the spring-loaded type.

In recalling my days under the Old Chief, I often marvel that shut-downs due to lack of power were not ten times more frequent than they really were. We had practically no standby equipment, except one very old Bailey-Davidson simplex feed pump. This, by the way, was built about 1871 at Salford, near Manchester, England, by the Sir William Bailey Engineering Works, and I would not be a bit surprised to learn it was still working. The boilers were not the flexible things they are today, and, like most of the plants of the day, we were "under-boilered" and understaffed. If a motor burned out we rented a "loaner" to tide us over the emergency. We became resigned to running, as the Old Chief expressed it, "without a spare tire."

For ten years I never knew what it felt like to be a free man on any of the public holidays, or even Christmas. All our major inspections, repairs and overhauls were made during these periods. I remember one of those hectic weekends when we inspected, or rather, rehabilitated the big Corliss engine. It was a race against time to complete the job and have her warmed up for 5 a m Tuesday morning.

When I came back to the plant in the afternoon, I found the Old Chief looking over a set of indicator cards that he had taken under normal load. He was very pleased with them. "Why," he said, "they look like 'Banshee' cards to me." The term "Banshee" was a new one on me, so he went on to explain it. When he was a young sea-going engineer, it was a custom that when indicator cards were coming off good or exceptionally good, the engineers who were not on the chief's watch would run off a number which they would hide away undated. Later, when for some unknown reason they were unable to secure good cards in a legitimate way, they would trot out these "Banshee" cards, date and turn them in, often saving a heap of embarrassing explanations on the carpet.

Speaking of unlawful methods of obtaining results, he told me about an elderly clerk, who on cold winter mornings would always carefully adjust his glasses and read the thermometer in the entrance hall. If it showed less than 75 degrees, the old gent was cold for the rest of the day, no matter what the inside or outside temperature might be. So the janitor made the old boy's life happy by hanging the thermometer on a radiator while he did his dusting, replacing it shortly before the office staff arrived. One morning he left the thermometer hanging too long, and the old gentleman complained that the place was "positively stuffy," so the janitor standardized matters by pushing the thermometer bulb up ten degrees, and left it at that.

Plastic Covers Eliminate Panel-Meter Glare

Objectionable glare from light striking gage and meter glasses can be eliminated by molding clear plastic to form a tilted face

By R C ULMER and N A KERSTEIN, *Research Dept, The Detroit Edison Co*

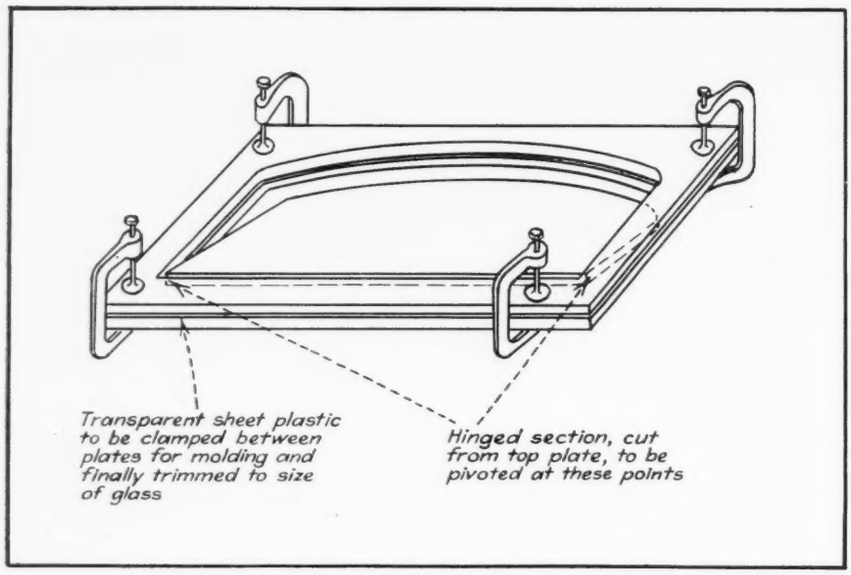

Transparent sheet plastic to be clamped between plates for molding and finally trimmed to size of glass
Hinged section, cut from top plate, to be pivoted at these points

Fig. 1—Die for molding tilted plastic fronts for replacement glasses in meter covers. Slight force applied to hinged section of plate deforms heated sheet to desired depth

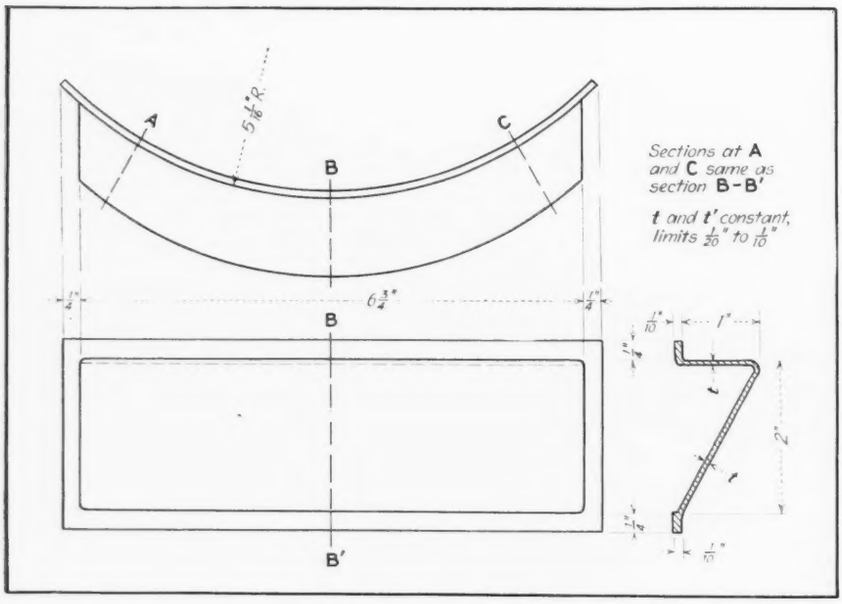


Fig. 2 Even the curved fronts of horizontal edgewise meters can be fabricated by properly shaped cutouts

► LIGHT STRIKING the cover glasses of panel-mounted instruments reflected into an observer's eyes is annoying and often causes difficulty in reading the instruments. Sources of such glare may be either natural or artificial lights.

Objectionable glare can be largely eliminated in new buildings being planned or under construction, by the location of instruments in positions so that light will not be reflected into the observer's eyes. Little can be done along this line, however, in the case of buildings already constructed. The solution of the problem, therefore, involves consideration of the instrument itself.

Investigations

Considerable work has been done by this company and other investigators on this subject. Most of the work has been concerned with glass treatment to eliminate glare. In this respect, investigations have been made in two directions (1) to etch the glass in such fashion that the light reflected from its surface will not be in one plane, which merely reduces the glare, because etching sufficient to eliminate glare reduces transparency of the glass so that it is difficult to read the instrument face, (2) to apply a transparent coating to the glass that will prevent or appreciably reduce light reflection.

This aspect of the problem has been investigated by Blodgett[1], Cartwright[2], and Strong[3]. Blodgett worked with organic films that greatly reduce reflection, but unfortunately are delicate and

[1] Blodgett, Katharine B. "Use of Interference to Extinguish Reflection of Light from Glass," *Physical Review*, Vol 55, No. 4, pp 391-404. See also U. S. Patent 2,220,862, low-reflectance class.

[2] Cartwright, C. H. "Process of Decreasing Reflection of Light from Surfaces, and Articles So Produced." U. S. Patent 2,207,656.

[3] Strong, John. "On a Method for Decreasing the Reflection from Nonmetallic Substances," *Journal Optical Society of America*, Vol 26, p 73.

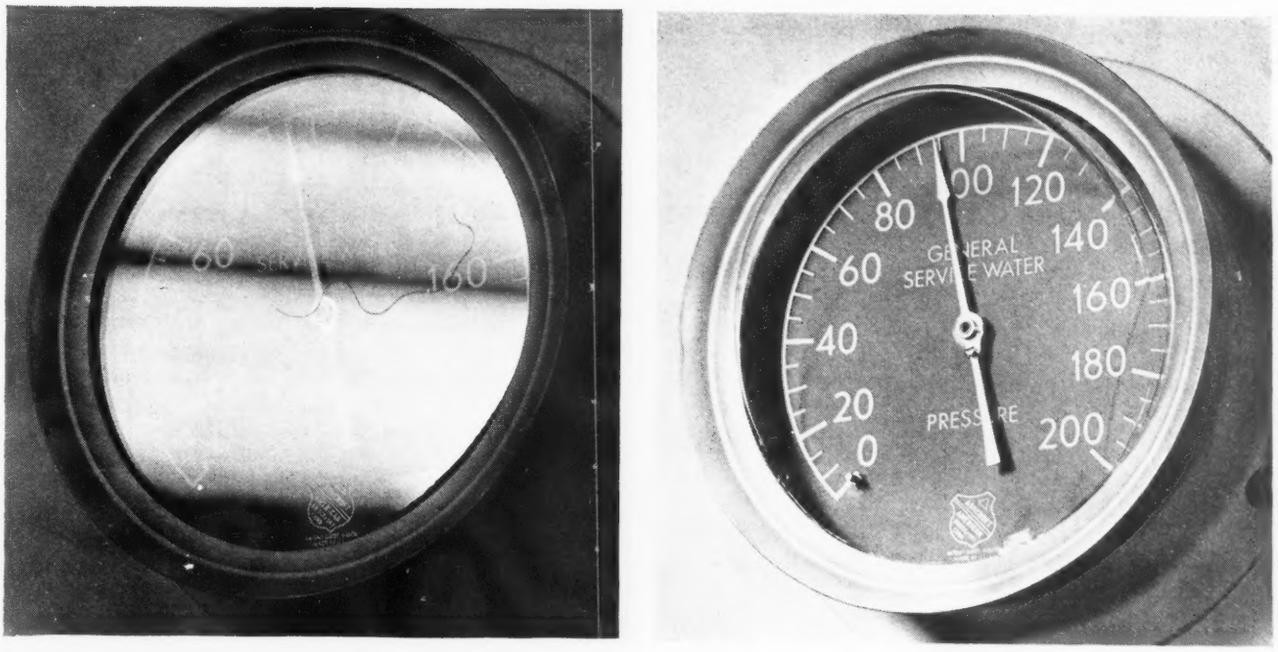


Fig. 3—Familiar glare condition, left, experienced with ordinary glass face, is completely eliminated by the correct tilt angle of plastic face right

easily marred. Cartwright and Strong used various evaporated inorganic films, including fluorides, that reduce reflection but do not entirely prevent glare. Many such films have the disadvantage that they are unstable in an industrial atmosphere although some prepared recently were found to be quite stable after a heat and oil treatment. These films were not considered further by this company because of their present high application cost.

Attempts have also been made to eliminate glare by altering the form of the instrument face so that reflected light would not all be in the plane of the observer's vision. For example, concave faces resembling large watch glasses have been used in place of the conventional round, flat type. These, however, were found actually to aggrevate rather than decrease glare since reflection was always present from some portion of the glass regardless of the direction from which it was observed.

Consideration was also given to redesigning the fronts of the instrument cases so that the glass would be at an angle and not reflect light in the plane of the observer's vision. This method was found to give satisfactory results as previously reported by McCallum[4] but unfortunately requires that the front of each instrument case be remodeled, and necessitates a different case for each type meter. This method would be very difficult to carry out with certain instruments; for example, those with horizontal edgewise curved fronts.

For these reasons it was decided to replace the present glass fronts in instruments with transparent plastic ones having angles of tilt such that no light would be reflected into the observer's eyes. This method has all the advantages of McCallum's method and in addition does not require altering the covers or cases. This process requires the forming or molding of the substitute cover faces with a tilt angle such that the intercepted light is reflected from the surface at an angle above or below the observer's line of vision.

In instances where only a few tilted cover-faces were required, they were pressed from sheet plastic by the type of apparatus shown in Fig. 1. A piece of thermosetting plastic sheet 0.020-

[4] McCallum, V E, "No Glare From These Glasses." *Electrical World*, Vol 108, p 720.

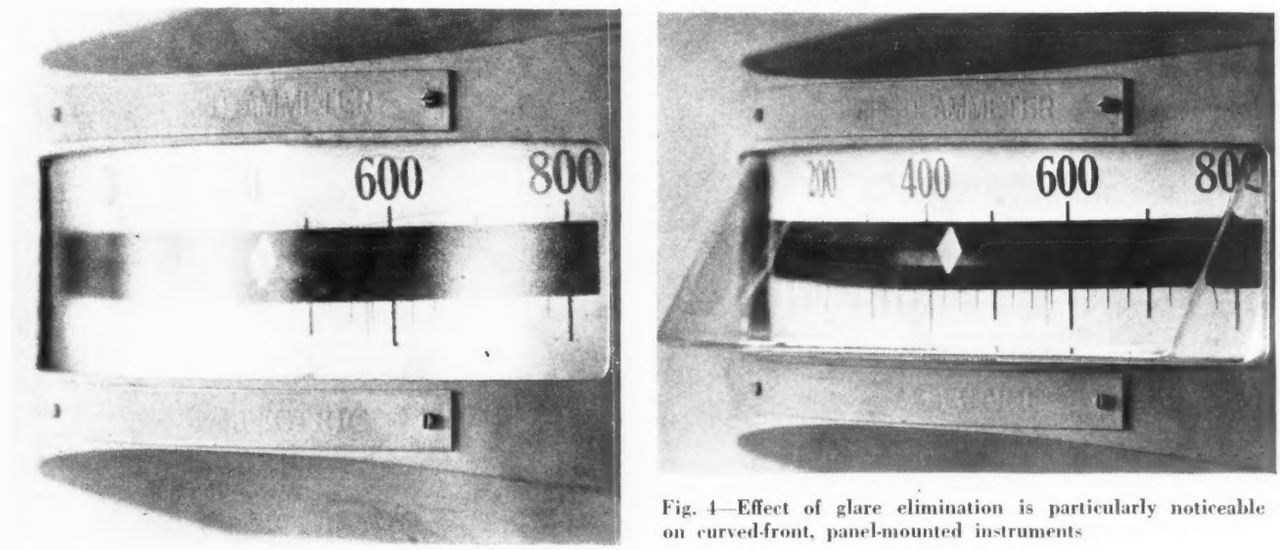


Fig. 4—Effect of glare elimination is particularly noticeable on curved-front, panel-mounted instruments

0.030-in. thick was fitted between two metal plates having matching cutouts the size of the cover-glass face and the assembly suitably clamped, as illustrated, with four small C-clamps. One of the pieces cut out was well polished and given smoothly rounded edges. This piece, replaced in the top metal plate, was hinged with pins at its lower edge. The whole assembly was then heated in an oven to softening point of the plastic.

A slight force applied to the hinged plate deformed the heated plastic sheet to a predetermined depth to give the desired angular tilt to finished cover-face. The assembly was then cooled before the plastic cover-face was removed and the face trimmed to fit the instrument case.

For large quantities of one size, a production mold was constructed. The use of such a mold made it possible to prepare plastic cover-faces, of the type shown in Fig. 2, for a large number of similar horizontal edgewise-type meters.

For the hand-molded fronts, Ethocell (ethyl cellulose) or Lucite (methyl methacrylate) approximately 0.020-0.030-in. thick was found suitable and easily worked for small instrument fronts. For the larger or more complex faces, like Fig. 2, thicker stock was required. For this purpose Lucite only was used.

This method of eliminating glare has been applied to various types of instruments and good results have been obtained. Figs. 3 and 4 are illustrations of converted instrument faces in actual use. The practicality of the suggested type of face for eliminating glare is obvious.

Cleaning of plastic faces must be done carefully in order not to create an electrostatic charge that might affect the accuracy of the instrument reading, and in order not to scratch or mar the plastic. Rubbing with a soft, damp rag has been found satisfactory.

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Dnieperstroy Dam—German View Shows Ruins

Press Association Photo

MUCH HAS BEEN PUBLISHED about the destruction of the great Dnieperstroy Dam by the Russian Army. Here is a radiophoto from Berlin, purporting to show a German officer with field glasses looking at the wreckage of the dam. The hydroelectric project was designed by the late Hugh L Cooper, a well-known American consulting engineer. Construction was started in 1927 and the plant went into operation in 1933. Its nine 84,000-hp turbines, designed for 116.5 ft head, were built by the Newport News Shipbuilding & Drydock Co, and the 77,500-kva, 0.80 pf generators by the General Electric Co. Under maximum head of 123 ft, the turbines could develop over 100,000 hp. The dam had a maximum height of 200 ft, and a spillway 2,500 ft long in the center, to take a maximum river flow of 835,000 cfs.

Get a True Sample First

Good boiler-water conditioning must always start with a "representative" sample, and every boiler should be equipped with proper sampling equipment. Here are some do's and don't's by Dudley K French

▶ WHAT IS MOST IMPORTANT about boiler-water treatment is the result, not theory alone. This result cannot become available unless the engineer or operator has before him the actual basic test-results on the treated water in just the same condition as when it is circulating through the boiler tubes. Only by sampling the water from an operating boiler can the engineer tell how well the boiler is being taken care of by the treatment he is using.

During the past ten years, it has been brought closer and closer to operating engineers that water improperly used in either power or heating boilers can cause a varied lot of troubles. At the same time, research sales effort and publicity have shown that intelligence and properly applied chemicals can greatly reduce, if not entirely eliminate, these troubles.

A growing industry has for years made money by marketing compounds or furnishing service to operators. At the same time, a constantly increasing prejudice has grown against anything that smacks of water treatment. Sometimes the sales side of the picture is to blame, but just as often the responsibility for failure to get results rests firmly on the operator's shoulders.

Treatment Results

An enormous amount of material has gone on record as to the results of chemical treatment in the removal or control of boiler water impurities. Many methods and materials are available. We all know much more than we did about what goes on inside an operating boiler.

For instance, we are acutely conscious that boiler conditions change greatly with every 10- or 20-degree increase in boiling temperature of the drum water. The problems multiply if much raw makeup is necessary or condensate returns are contaminated. Realizing these facts, we begin to understand that it is foolish, and possibly dangerous, to apply one or another dosage on the basis of external evidence alone.

Assuming an operator is convinced of the need of constant knowledge of his boiler-water conditions, just what does he do next? It is easy to say, "Just take a 'representative' sample of your boiler water." It is another matter entirely to accomplish the "representative" part.

The boiling temperature within a closed vessel increases about one-half degree F for every pound pressure increase. If boiler water is released to atmosphere we are familiar with the fact that part of the water will evaporate into clouds of steam. As the steam released was part of the boiler water, it should be a part of any true sample taken outside of the boiler. If a sample is permitted to become partly evaporated. the remainder is apt to be poorer (higher concentration of solids) than is actually the case within the boiler.

Large plants, and those with technical control by feedwater specialists, have devices that aid in getting repre-

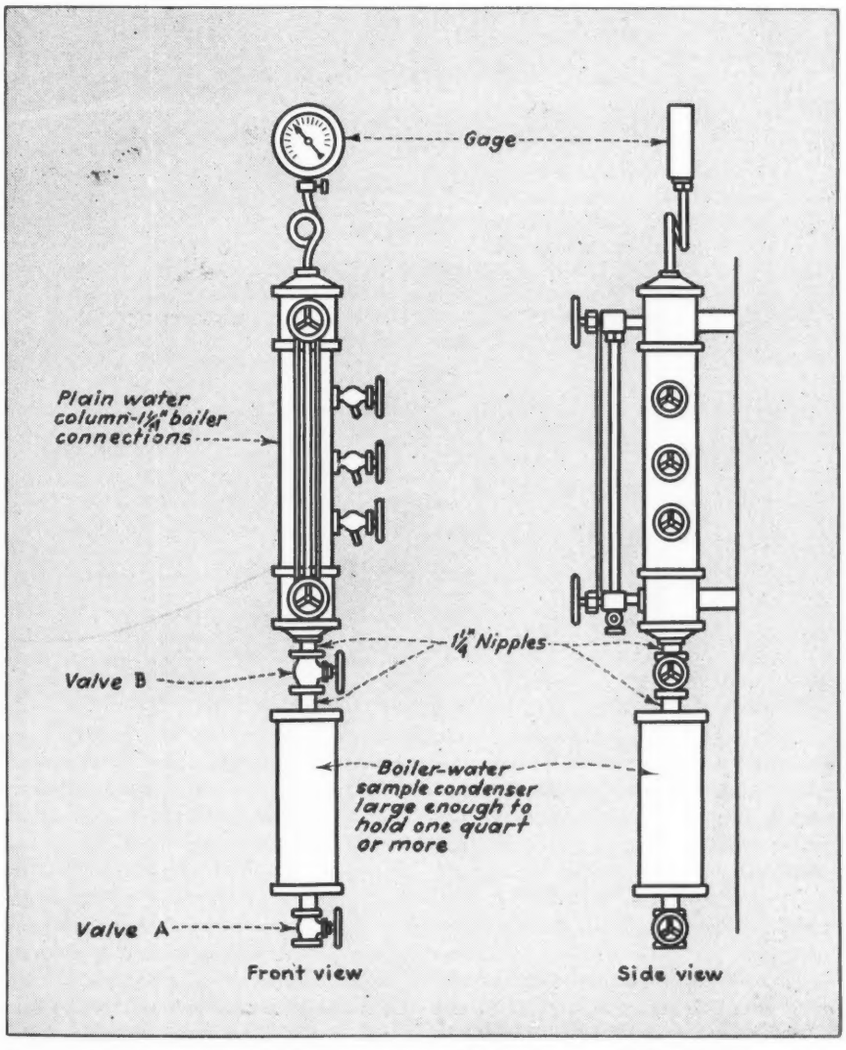


Fig. 1—Simple container attached to water column acts as sample condenser. Open both valves to blow through, then close valve *A*. About five minutes later close valve *B*. After 30 min draw off sample into clean container, covered to keep out air

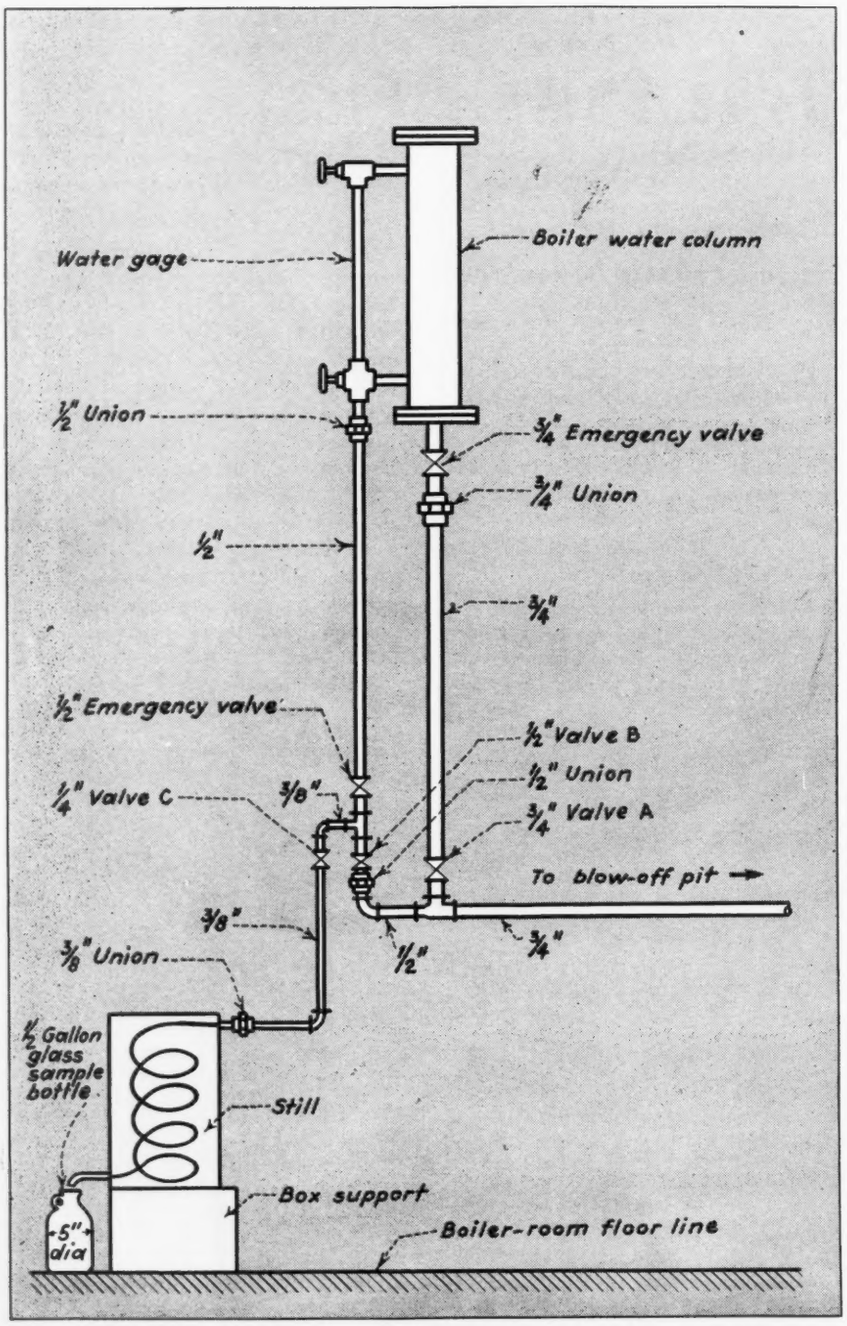


Fig. 2—Piping connection and coil condenser provide useful permanent arrangement for sampling. First fill condenser with cold water and open valve *A* for one minute to clean column and piping. Close *A* and open *B* for one-half minute to clean water-gage and drain piping. Close *B* and open *C* wide for 10-15 seconds to clean condenser tubes, then throttle *C* to about one quart per minute flow rate

sentative samples. Possibly the simplest arrangement is a container or pipe section capable of withstanding the boiler pressure connected into the water-column drain with a shut-off valve on either side, as in Fig. 1. The container section should hold a quart or more.

In collecting a sample with this system, both valves are opened until the sampling line is freed from condensate and drum water is veing vented. Then the outer valve *A* is closed. A few minutes later the inner valve *B* is closed, trapping a sample. After standing long enough to cool to a temperature at which it can be drained, the sample can be slowly drawn off.

A thorough blowing out of the sampling container and piping before collecting the sample is necessary to insure that both are completely filled with boiler water. Any empty space will tend to evaporate water from the sample as the assembly cools, thus changing the proportion of solids to water in the sample.

Another point often overlooked is the possibility of suspended scale being carried down into the sampler and redissolving in the cooler water. Just as a temperature-rise can cause the deposition of sludge, so can cooling increase the solubility of suspended material in the sample. The results of that analysis will not represent true conditions within the drum. Installation of a copper screen with a fairly coarse filter paper between a pair of flanges in the sampling line will remove most of the suspended matter. The filter paper can be removed and renewed when necessary.

Another type of sampling device is detailed in Fig. 3. A bypass around the water-column drain is fitted with a small sampling line leading to a coil condenser. After a thorough blowing out of the piping, the sample can be collected continuously as long as condenser-coil capacity is not exceeded.

With any type of sampling equipment, caution should be taken that the sampling point takes water representative of the boiler water. In some cases the inlet feed-line is near the water column and a sample from the column drain will be heavily contaminated with raw feed. In such cases the sampling point should be located at another point, such as the blowdown line.

Supplementary Treatment

If the feedwater carries supplementary and excess treatment that will contaminate the sample, it is a good idea to cut off the chemical feed for about 15 minutes before collecting the sample.

Blowing down the boiler also disturbs the concentrations in various parts of the circulating system in addition to generally reducing the solids concentration of the whole water content. A boiler-water sample should represent a normal condition, not the case just after blowing down. It is better, however, that the sample represent a poorer rather than a better than average condition and sometimes it may be best to err on the side of sampling before blowdown.

Much depends on the judgment of the boiler operator as to when and where samples should be taken. Load changes affect water conditions and may dictate frequent sampling to determine what is going on inside the boiler. In other instances constant load conditions may require sampling at intervals of several days. The important consideration is that the operator know the condition of his boiler water, and proper sampling is the first step toward proper water treatment.

THE OPERATING ENGINEER

George Edwards
Advisory Editor

Practical Aids
Maintenance Hints
Questions — Answers

Published monthly as an integral part of POWER

Meters Guide Hospital-Plant Operation

Modern-equipped boiler plant, backed by automatic control and metering facilities, insures reliable, efficient and low-cost operation of the new Delaware Hospital

ESTABLISHED over 50 years ago in a building with 30 beds, the Delaware Hospital, Wilmington, Del., had grown by 1938 into a large institution occupying a number of separate buildings. At this time funds were made available for an extensive expansion and modernization program. Massena and duPont, Wilmington architects, were employed to prepare designs for a new building that would house all departments, provide space for 350 beds and permit future expansion to 700. The new 10-story reinforced-concrete brick-faced building is now being built in three sections on the site of the old ones. Regular hospital service is being maintained at the same time.

Plant Design

Like all modern hospitals, this one requires large quantities of steam for building and water heating, sterilizing, cooking and operating a large laundry. For these services an entirely new boiler plant has been installed, plans and specifications for which were made by Jaros, Baum and Bolles, consulting engineers, New York, N. Y. This plant is modern in every detail and equipped with meters and automatic control so that it can be operated under practical test conditions at all times.

Steam and power service to a hospital must, above all, be reliable. A failure of either during a critical surgical operation or similar situation might result in death. Therefore, in designing the boiler plant for Delaware Hospital, the engineers attempted to get 100% reliability without unnecessary duplication, and at the same time insure good operating efficiency.

To this end three straight inclined-tube, cross-drum boilers were selected. Two of these will be sufficient to handle the maximum heating load, leaving one spare. Each boiler has 2,920 sq ft of steam making surface, and is rated at 16,500 lb per hour. Designed for 160-lb-per-sq-in. pressure, they will operate at 100 lb. Water tubes are 4 in. in diameter and are set 10 rows high, 12 and 13 tubes wide, with two rows of return tubes from front head to the steam drum. The boilers are baffled for three passes and are set in solid-brick, partial-steel-incased settings.

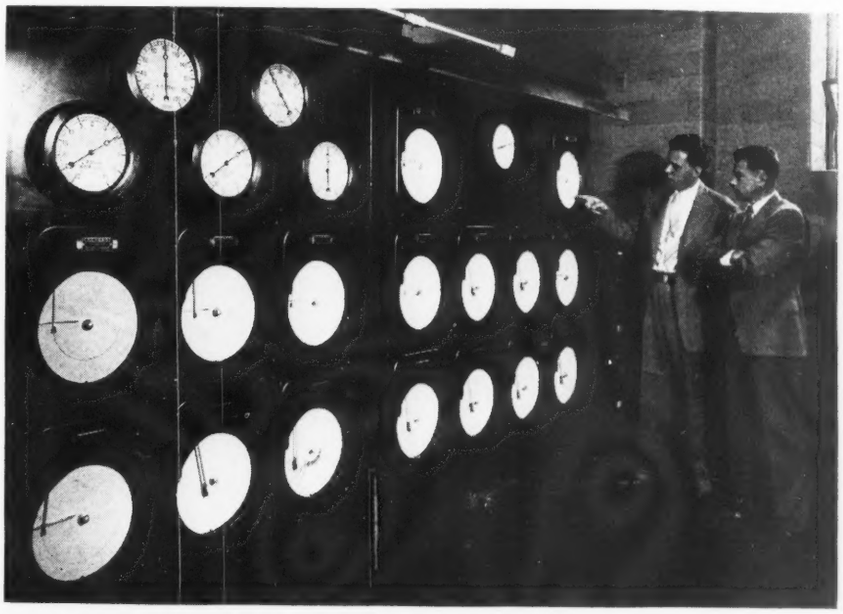


Fig. 1—Chief engineer Carl A Baehr explains to Gabriel Massena, partner, Massena & duPont, architects, how information obtained from these meters keeps hospital operating costs down by showing steam and water distribution

To eliminate dust, dirt and noise as much as possible in boiler-plant operation, oil firing was selected. Because the plant is located near tidewater, oil can be easily obtained at reasonable cost. Its use greatly simplified operation and automatic control.

Fuel oil is obtained by truck and

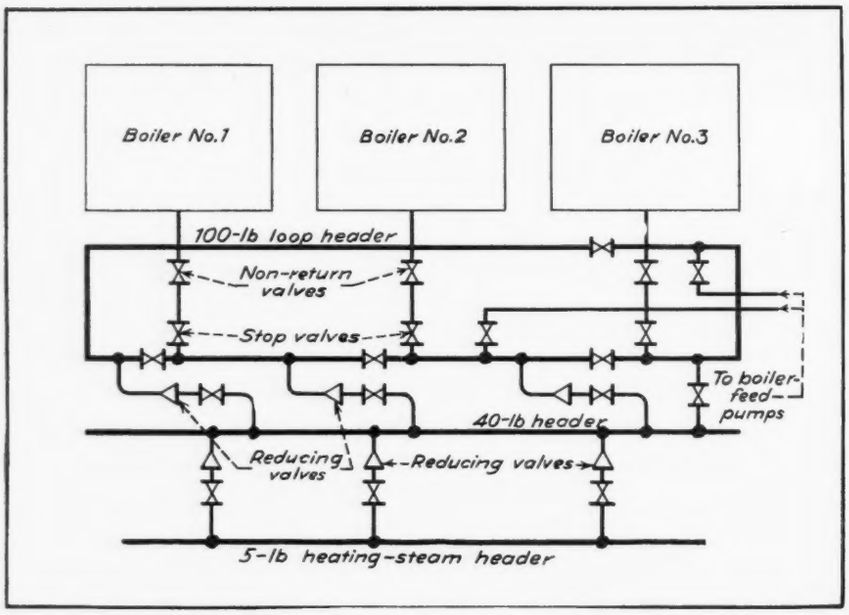


Fig. 2—Sectionalized-loop steam header insures practically 100% reliable steam distribution from boilers to all parts of the hospital

stored in two 18,000-gal tanks, sufficient storage for about 12 days' operation at maximum heating requirements. Due to the contour of the property and location of the plant, oil tanks are placed so that their bottoms are 5 ft above the center line of the two fuel pumps. This gives from 5 to 13 ft static head at pump suctions, depending upon how full the tanks are. Even at maximum operation a positive dynamic suction head is insured at the pumps, increasing their reliability.

A direct connection from the bottom of each tank and another extending 6 in. up into them lead to a pump suction header, to which the two screw-type fuel-oil pumps connect. Either pump has sufficient capacity to supply maximum firing requirements. When the installation was made it was intended that oil would be taken out of the tanks through the higher connections. Dirt and sludge would then settle into the bottom, for periodic cleaning.

Experience has shown that the oil can be taken directly from the bottom of the tanks without serious trouble in the strainers or burner nozzles. Occasionally a truck-load or two of bad oil may cause some trouble. At such times oil is taken from the high-level connections for a day or so. After that oil can be taken from the bottom of the tanks without further trouble. In this way it has been possible to eliminate sludge collection in the bottom of the tanks and save a cleaning job.

Oil lines are equipped with strainers ahead of the pumps, after the oil heaters and at the burners. In winter these strainers are cleaned every week and in summer every two weeks. This has been found sufficient to insure free oil flow to the burners. Coils for heating the oil with steam are provided in each storage tank. These heaters are used only in the inactive tank, to maintain a temperature that will insure flow to the pumps any time it might be necessary to switch from the active to the inactive tank.

Thermostatic control maintains oil temperature automatically. Return of excess oil through the bypass to the active tank has been found sufficient to maintain oil temperature in that tank. The oil preheaters, after the pumps, use steam and automatically give a temperature at the burners of 185 F. An electric heater is also provided at each burner. This heater is thermostatically controlled and is used only when starting a burner or if the oil temperature drops below 180 F.

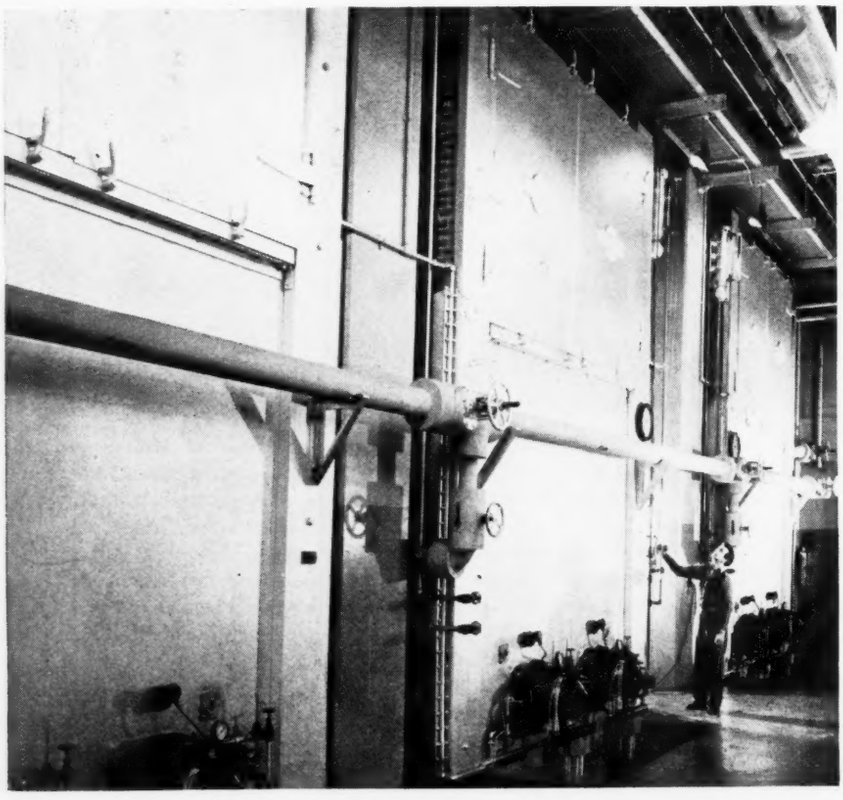


Fig. 3—Designed for 160-lb-per-sq-in. pressure, these boilers operate at 100 lb

Boilers Oil Fired

Each boiler is fired with two forced-draft mechanical-atomizing burners, set on a horizontal center line 22 in. from the furnace bottom, under the high end of the boilers. The furnace is an approximate cube, being 8 ft wide, 10 ft long, and 10 ft high (maximum), giving a total volume of 770 cu ft. After 10 months operation, no trouble has been experienced with the furnace walls and combustion conditions can be maintained to give 13% CO_2, without getting into the smoke zone.

Burner operation is fully automatic. They are equipped with both gas and electric ignition and protection against feeding oil to the furnace if the flame goes out. To start a furnace, the automatic control is energized by closing the power switch. The control then starts the fan motor, lights the gas and

electric ignition and energizes the electric oil heater. As pressure in the furnace increases, the furnace-draft regulator opens the uptake damper. After a predetermined period, oil is automatically admitted to the burner at a low firing rate.

If the oil ignites, the control gradually opens the fuel valve to maximum firing. If the oil does not ignite, then, after a predetermined period, the loss-of-flame protector cuts out the control and closes the fuel valve. This locks the control, and it cannot start the burners again until someone pushes the reset button. If for any reason the flame goes out after the burners are in operation, the protective device takes the burner out of service and locks it out until the reset button has been pressed.

Normally the control holds steam pressure at practically 100 lb, but during the summer months the load may become so small that steam pressure cannot be held down even on minimum firing. Under such conditions the control cuts the burners out at 104 lb and restarts them when pressure drops to 100 lb.

To give the steam end of the plant the high reliability designed into the fuel and firing equipment, the three boilers connect into one side of a sectionalized loop header (Fig. 2). A connection is taken from each boiler section of the header through a reducing valve to the 40-lb header. This header connects by three reducing valves to the 5-lb heating-steam header. Between the 100- and 40-lb header there is also an emergency connection with a manually operated valve.

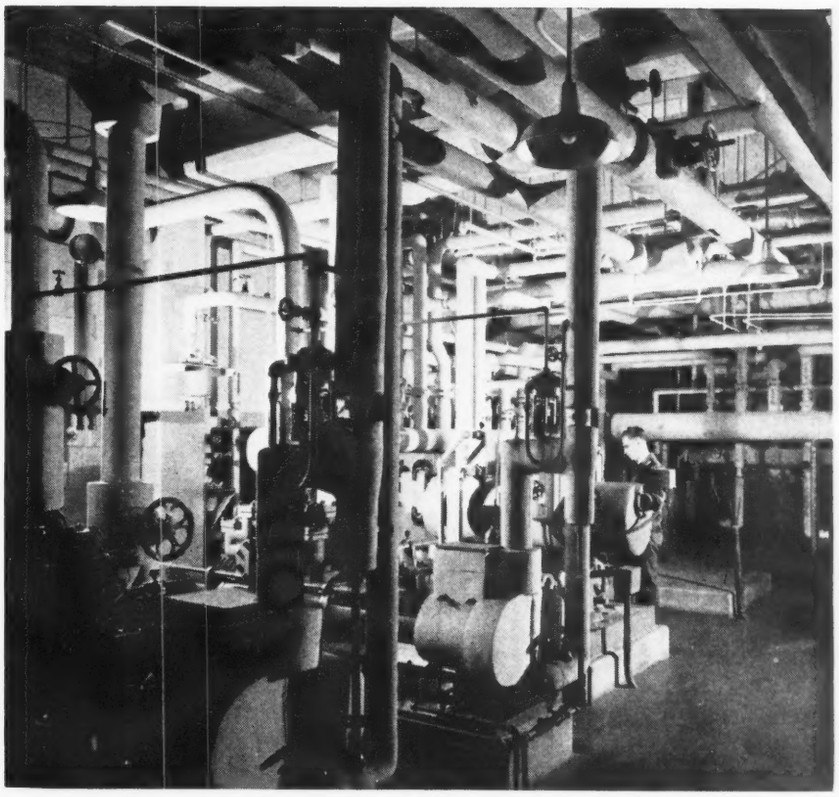


Fig. 4—All steam and hot-water lines, and the steam end of the boiler-feed pumps are thoroughly insulated to prevent heat losses

Steam for the feed pumps is taken from two different sections of the boiler header. Feedwater is supplied through a loop header by two direct-acting steam pumps. These piping hookups make it possible to feed water into the boilers and take steam away from them under practically any conditions, thus insuring that steam will be available when and where required.

Meters are provided so that a complete record of boiler performance can be maintained. A board near the boiler fronts has a panel for each boiler. Each panel carries a single-point gage to measure furnace draft, and an indicating and recording CO_2 meter. An indicating, recording and integrating steam flowmeter shows the boiler load at all times and maintains a record of steam produced. A second pen on the steam-flow chart records flue-gas temperature as it leaves the boiler, providing a check on gas-passage cleanliness. A meter at the bottom of each panel records and integrates feedwater flow. In addition, continuous-blow-down discharge, fuel-flow to each burner, and bypass flow back to the fuel tanks are metered.

The office of chief engineer Carl Baehr, who has full charge of the boiler plant and all services throughout the hospital, overlooks the boiler-room

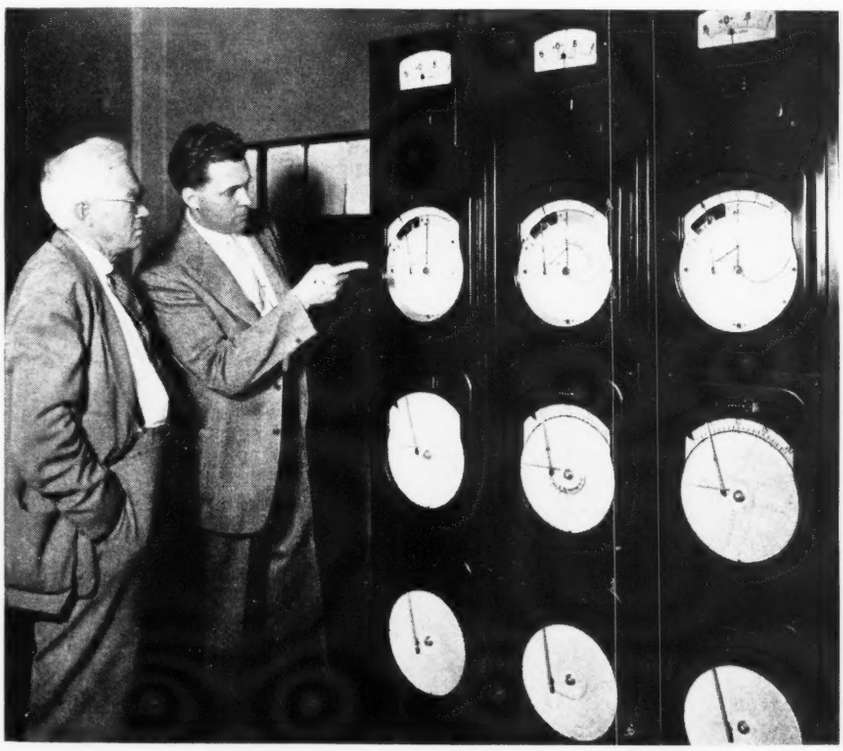


Fig. 5—Here is chief engineer Carl A Baehr (left); this time he is giving Associate Editor F A Annett some fine points on boiler operation

Principal New Boiler-House Equipment

Delaware Hospital, Wilmington, Del.

Steam-Generating Equipment

Boilers, 3 ..... Edge Moor Iron Works

Heating surface 2,920 sq ft; rated maximum continuous steaming capacity, 16,500 lb per hr; design pressure 160 lb per sq in.; working pressure 100 lb per sq in. (saturated); effective furnace volume 770 cu ft; Btu liberated per cu ft of effective furnace volume at maximum rating, 28,500.

Stack ..... Rust Engineering Co
Boiler settings ..... Rust Engineering Co
Soot Blowers ..... Diamond Power Specialty Corp
Gage columns ..... Reliance Gauge Column Co
Blowoff valves ..... Yarnall-Waring Co
Safety valves ..... Manning, Maxwell & Moore
Non-return valves ..... Foster Engineering Co
Stop valves ..... Chapman Valve Mfg Co; Lunkenheimer Co
Reducing valves ..... Foster Engineering Co
Piping contractor ..... Benjamin F Shaw & Co
Pipe insulation ..... Keasbey & Mattison Co
Traps ..... Warren Webster & Co; Strong Carlisle & Hammond Co; Armstrong Machine Works

Combustion Equipment:

Oil burners ..... S T Johnson Corp
Oil-burner automatic control ..... Minneapolis-Honeywell Regulator Co
Automatic furnace-draft regulator ..... A W Cash Co
Automatic stack-draft adjuster ..... Preferred Utilities Mfg Co
Oil heaters ..... Davis Engineering Co
Steam regulators on oil heaters ..... Powers Regulator Co
Oil strainers ..... Chas M Bailey Co
Oil pumps ..... Quimby Pump Co
Oil pressure and temperature control ..... Powers Regulator Co
Safety valves on oil pumps ..... Lunkenheimer Co

Feedwater Equipment:

Feedwater heater ..... Swartwout Co
Feed pumps, 2, direct acting ..... Union Steam Pump Co
Feed-pump governor ..... Foster Engineering Co
Lubricators on feed pumps ..... S F Bowser & Co
Continuous blowdown ..... Henszey Co
Condensate-return pumps ..... Nash Engineering Co
Hot-water circulating pumps ..... Quimby Pump Co

Meters and Instruments:

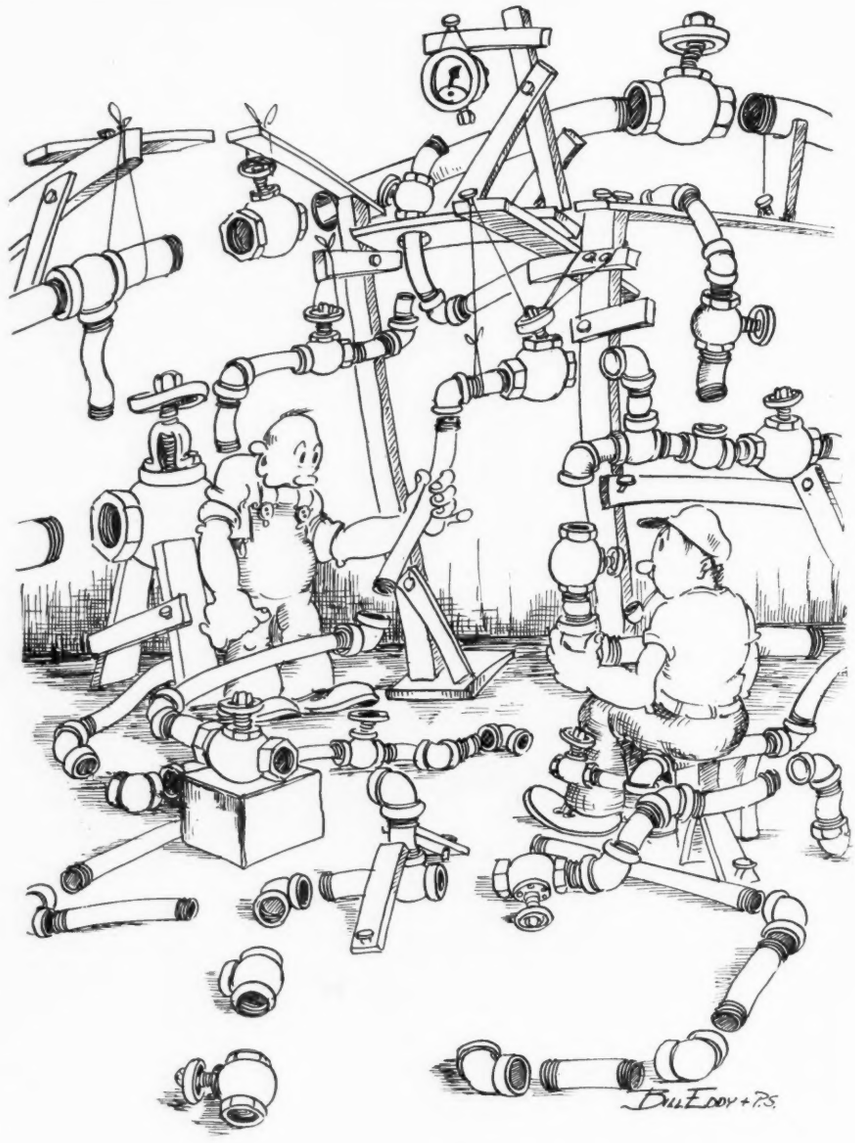
Steam flowmeters and recorders ..... Cochrane Corp
Feedwater flowmeters and recorders ..... Cochrane Corp
Steam-pressure recorders ..... Cochrane Corp
Flue-gas temperature recorders ..... Cochrane Corp
CO_2 recorder ..... Hays Corp
Oil flowmeters ..... Buffalo Meter Co
Blowdown meters ..... Henszey Co
Temperature recorders ..... Cochrane Corp
Oil-level indicators ..... Petrometer Corp
Draft gages ..... Hays Corp
Steam-pressure gages ..... Manning, Maxwell & Moore
Pressure gages on master panel ..... Ashton Valve Co
Dial thermometer ..... Bristol Co

operating floor. Near his desk stands the distribution-meter board, for steam and water, Fig. 1. At the top of the left-hand panel five indicating pressure gages show pressure in the main steam header, medium-pressure header, low-pressure heating-steam main, heating-system return line, and steam line to hot-water-tank heating coils. Below the indicating gages three meters record pressure in the high-, medium- and low-pressure steam mains. A meter at the bottom records feedwater temperatures and two other meters show steam flow to kitchens and laundry.

At the top of the right-hand panel a dial thermometer shows outside temperature. Recording thermometers chart temperature of hot water to laundry, kitchen, and general hospital services. Meters on the incoming cold-water supply, laundry hot- and cold-water lines, kitchen hot- and cold-water lines and general service hot- and cold-water lines record flow to these services.

The third and last section of the hospital is now under construction. When this is completed, and the whole hospital is in service, Chief Engineer Baehr will be able to maintain records of power, steam, and water costs and their distribution that will present the intelligent picture of plant operation.

Acknowledgment is here given to C A Hume, hospital superintendent; H W Cornelius, Massena & duPont, architects; A L Baum, Jaros, Baum and Bolles, consulting engineers; B F Lownesbury, project engineer, Benjamin F Shaw Co, installation contractors for all steam, heating, air conditioning and conveying equipment; and to chief engineer Carl A Baehr for assistance in preparing this article.



"Now it's up to OPM to finish it"

FOR THE DIESEL PLANT

An Easily Made Lube-Oil Reclaimer

By H O MUNSON

FOR OUR SMALL DIESEL PLANT (four 200-hp units) we designed a lube-oil reclaimer that is a little different from any that I have seen or read about. Several engineers who visited our plant copied the design and report that the reclaimer is a great success, because of simplicity in both operation and construction.

A reclaimer of this type may be made from any barrel or tank available, size being governed by amount of oil to be handled. We used an old electrolytic lightning-arrestor tank, of about 65 gal capacity. A 2000-watt tank-heater was mounted on the side of the tank, as shown in the sketch. The pipe from the bottom of the heater is carried to within 4 in. of tank bottom, leaving space for sludge to settle. A spray head, just under the tank lid, tops the pipe from upper heater outlet. We made the spray head by boring five or six ¼-in. holes around the circumference of a ¾-in. pipe coupling and closing the top with a pipe plug.

Clean-oil Drain

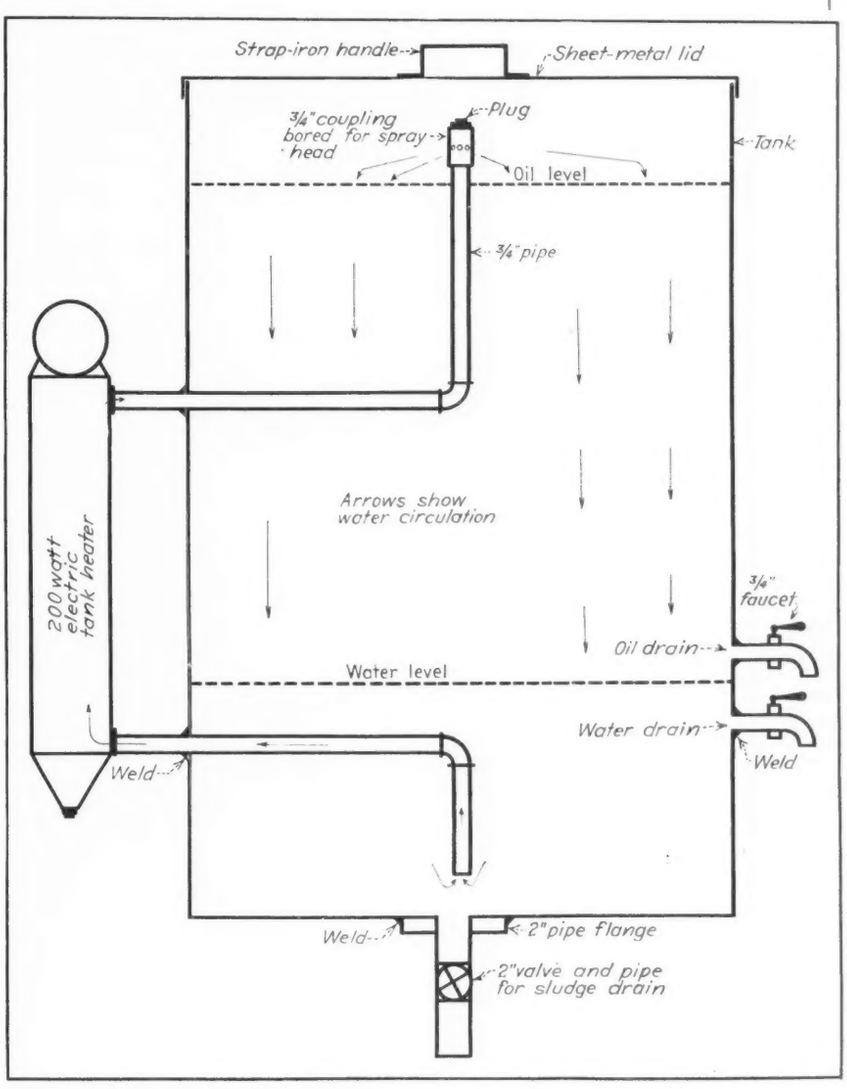
Installation of two ¾-in. faucets, in the position shown in the sketch, provides a clean-oil drain and control on the water level. The sludge drain consists of a 2-in. flange welded to the center of the tank bottom, plus a 2-in. nipple and valve.

To operate the reclaimer, fill tank with water to a point about midway between the faucets. For each ten gal of oil capacity, dissolve 1 lb of soda ash in a pail of water and pour into the tank. Fill tank with dirty oil to about 2 in. below the spray head, cover the tank, and turn on the heater. Thermal action causes the water to circulate as in a coffee percolator. Water enters the heater from lower part of the tank, which, after heating, spouts out through the spray head. This distributes the water over the oil surface. As the water settles through it washes out impurities and heats the oil.

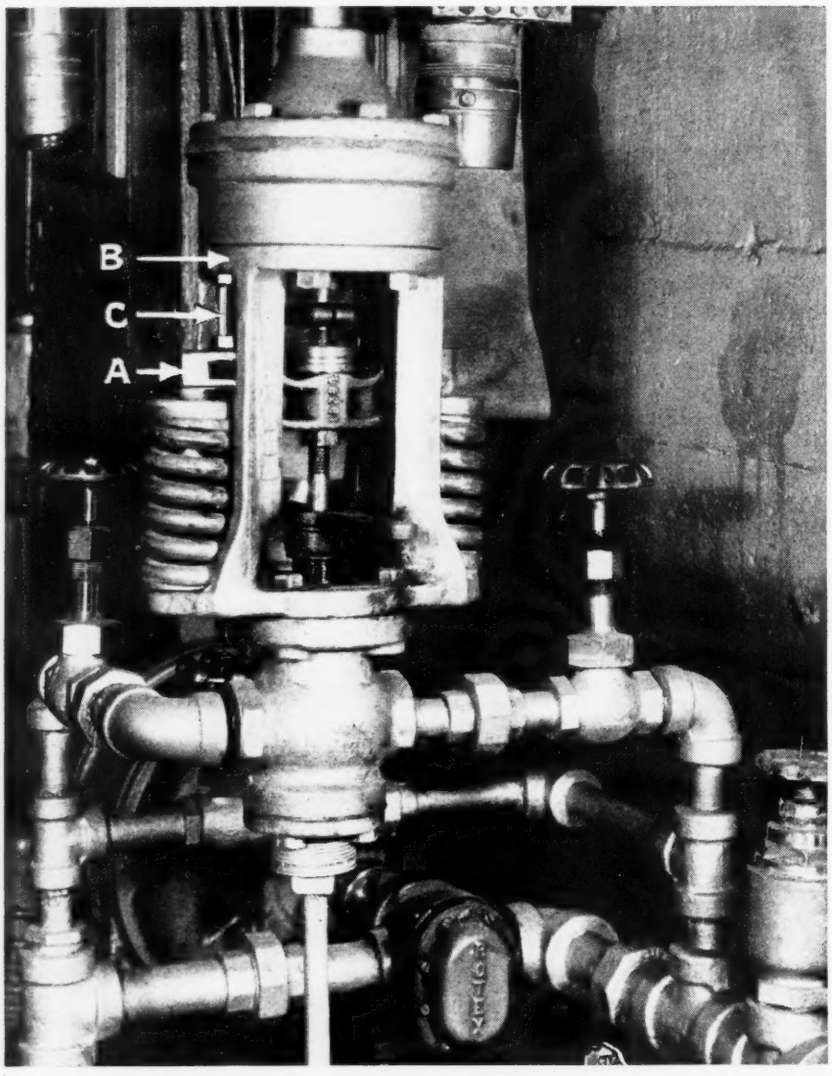
Operating time depends on initial oil and water starting temperatures. A 40-gal reclaimer with a 2000-watt heater should run 7 or 8 hours until oil temperature reaches 190 F. Allow to settle for 12 hours before draining off clean oil. The lower faucet controls water level; drain off water until clean oil flows from upper faucet.

Water alone may be used in this reclaimer with good results, but the oil film around the dirt particles causes most of the sludge to float on top of the water, making water and oil-separation at the faucets difficult. By using soda ash this film is broken, and the sludge settles to the bottom of the tank. Depending on the amount of contamination in the oil, one to five batches may be reclaimed with the same charge of water and soda ash before it becomes necessary to remove accumulated sludge.

All engines in our plant are crankcase scavenging; oil returned to the crankcase passes through a bag filter and into the supply tank to be recirculated through the engines. We found that the filter did not remove the finely divided dirt and carbon, and after the engine operated for a few months the concentration of impurities in the oil amounted to as much as four ounces per gal. To correct this condition, the lube-oil circuit was opened at the crankcase drains; all oil coming back from the engine is caught at this point and taken to the oil reclaimer. Clean oil is used to maintain the level in the supply tank. As only clean oil is fed to the engine and goes through the engine only once, a washing action occurs which keeps pistons, cylinders and crankcases in perfectly clean shape, preventing ring-sticking and reducing sludge.



PRACTICAL AIDS TO OPERATION



Limit Improves Valve Operation

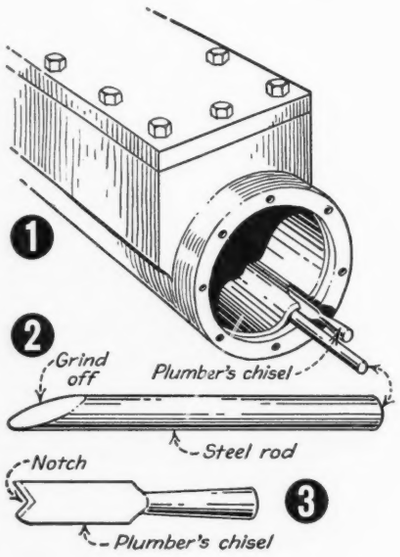
THE AUTOMATIC BYPASS VALVE on our rotary fuel-oil pump, located several feet from the pump, was very unstable in its operation. To correct this trouble I installed the valve as in the figure, directly on the suction and discharge piping. The valve diaphragm chamber connected to the main steam line leading to a 300-kw engine-driven generator. Even in the new location the valve tried to follow the steam-pressure pulsations caused by the opening and closing of the admission valves on the engine. These pulsations were transmitted to the burners and into the furnace.

To remedy this condition we drilled and tapped the front boiler drums and connected the regulator to these drums, which do not connect directly to the steam main. This eliminated the effects of the steam-pressure pulsations, but not all the trouble.

At 100- to 150-lb oil pressure, the regulator diaphragm seemed to reach a critical point where it would go to one or the other extreme valve position. This action caused very bad firing conditions. As a step in correcting this we placed a block of wood in between the spring yoke *A* and the diaphragm chamber *B* to limit bypass-valve movement and give maximum oil pressure of 180 lb.

This corrected the trouble so we drilled and tapped each end of the spring yoke for a ⅜-in. tap bolt. These bolts were installed as at *C* and adjusted for a maximum oil pressure of 180 lb. Since then the regulator has operated satisfactorily and has saved several times its cost by improving boiler and furnace efficiency.

New York, N. Y. P E MERIDETH
Chief Engineer, Eldorado Hotel



Vee-End Chisel Cuts Cylinder Liner

VARIOUS SCHEMES ARE USED for removing worn liners from reciprocating-pump cylinders, but like Major Bowes' amateur harmonica players, I think my method is best. First, I take a piece of round iron 2 or 3 in. longer than the cylinder and grind it to an edge at one end, Fig. 2. I drive this under the old liner, Fig. 1. Then with a plumber's chisel ground as in Fig. 3, I cut the liner along the bar by driving with a hammer. The vee cutting edge holds the chisel in place on the liner and makes cutting easy.

Riverdale, N. Y. ALEX GRAY

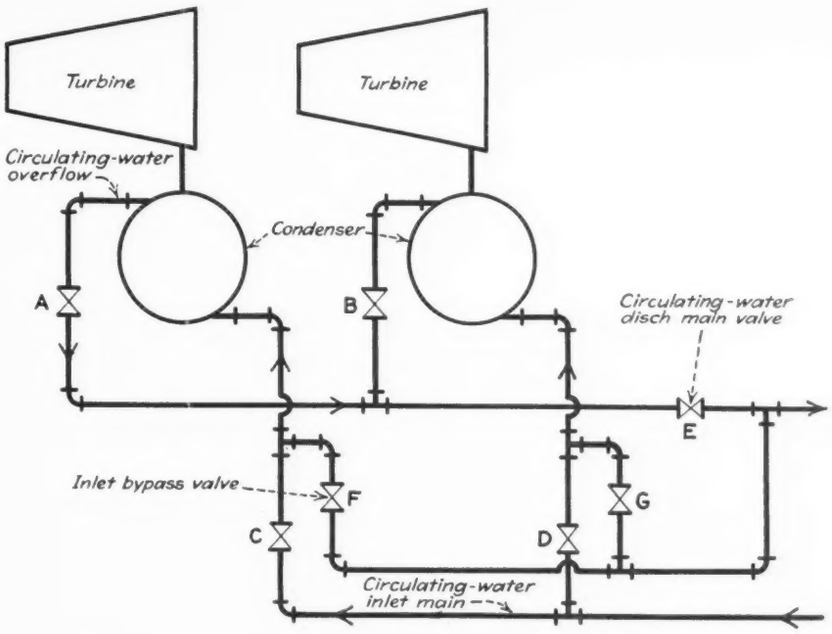
Detecting Invisible Cracks in Metal

WHEN INSPECTING EQUIPMENT there sometimes may be a suspicion of a crack that cannot be seen. Several easily applied methods are available for detecting such cracks. First, thoroughly clean the area in which the crack is supposed to be. Then paint the area with machine oil and allow it to remain for a few minutes. Wipe the surface dry and apply a coating of chalk rubbed on with a cloth. Any cracks will be indi-

cated by oil coming out of them and staining the chalk. This test may be accelerated by tapping the area lightly with a hammer.

Another test is to use a mixture of gasoline and red lead applied to the suspected area after it has been cleaned thoroughly. The gasoline will evaporate in a few minutes, after which the red lead is rubbed off with a clean cloth. Any fine cracks will be indicated by thin veins of red lead. A mixture of whiting and water about the consistency of cream may also be applied to the suspected area after it has been cleaned. Permit the coating to dry, after which the whiting will absorb enough oil from invisible cracks to indicate their location if they are present. A magnifying glass will prove helpful.

Brooklyn, N. Y. F V FAULHABER



Condensers Cleaned by Reversed Water Flow

WHEN THE RIVER WATER CARRIES considerable quantities of leaves and other debris in the fall of each year it causes trouble in the condensers on our two extraction turbines, by blocking the inlet ends of the condenser tubes. To clean out the condensers we arrange the circulating-water piping, as in the diagram, so that flow could be reversed through either condenser. Normally valves *A*, *B*, *C*, *D*, and *E* are open and valves *F* and *G* are closed to permit the water to enter the bottom of the condenser casing and leave at the top.

If we want to reverse the flow through the right-hand condenser we open valve *G* and close valves *D* and *E*. Then the flow is through the left-hand condenser up through valve *B* into the outlet of the right-hand condenser and out through its inlet, valve *G* to the discharge line. A few minutes of reverse flow cleans the trash out of the condenser, then it is put back into normal operation. To reverse the flow through the left-hand condenser, valve *F* is opened and valves *C* and *E* are closed.

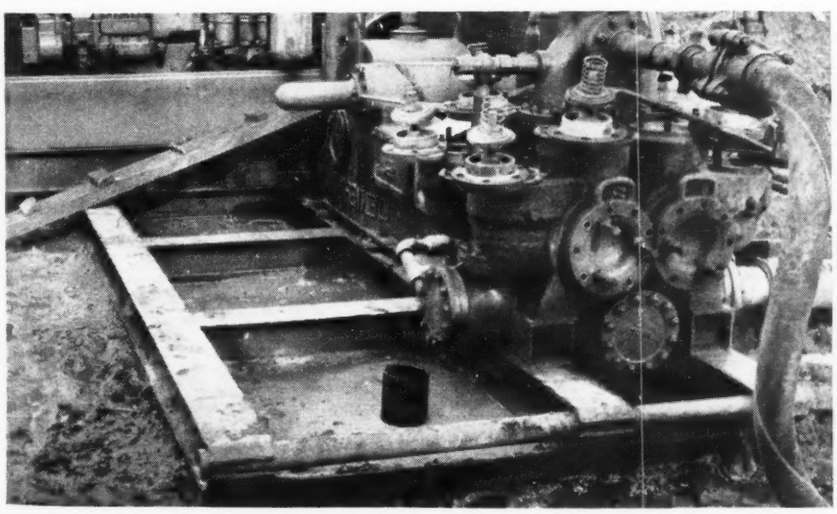
Roanoke, Va. S H COLEMAN

Plate Simplifies Installation Work

ON CONSTRUCTION WORK, or where equipment must be set up temporarily on soft soil, the problem of installation can be simplified as shown in the figure. On this job pumps and other equipment were mounted on H-beam structures. To permit them to be placed on any level spot we covered the bottom of the H-beam structure with a $\frac{3}{16}$-in. steel sheet and tack-welded it to the beams. Now any vibration tends to work the base down to a more solid foundation.

The steel sheet adds comparatively little to the weight of each piece of equipment and saves time and loading space while transporting. The steel-inclosed base is also a convenient place to store parts needed for setting up the equipment.

Pomona, Calif. G M WILSON



Pilot Gage for Base-Load Operation

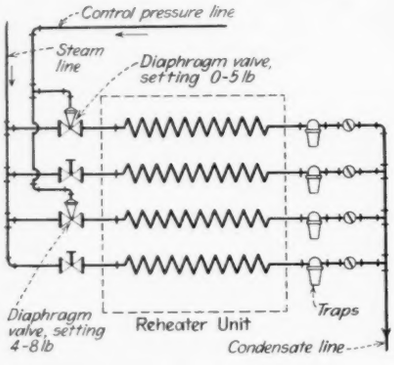
BASE-LOAD, STRAIGHT-LINE OPERATION of the system's most efficient steam units whenever possible seems to be the accepted practice. The main reason for such operation is that it allows more efficient combustion than is possible when carrying a varying load. With a single boiler supplying steam for a single turbine, it is practicable to operate with the governor set so that all the turbine-control-valves are wide open and to control generator output, within narrow limits, by varying the boiler pressure.

While trying to maintain a given pressure the fireman watches the master pilot gage, since it has a greatly magnified scale. This gage is connected to the superheater outlet to indicate, as soon as possible, the change in turbine steam-demands when carrying a variable load. With straight-line or pressure-

controlled operation there is only one variable factor, the fuel-air mixture to the furnace. Due to the pressure-drop across the superheater, there is a slightly greater change at the drum than at the superheater outlet, hence a small time lag in making adjustments in the amount of fuel fed. This in turn allows the pressure to drop or rise still further before the change in feed can be reflected by the pilot gage.

That this is true has been proven by hanging a magnifying glass over the drum pressure-gage pointer and firing by it for a period of a few hours. The fireman was able to maintain much straighter pressure and temperature lines, as recorded at the turbine, with much smaller and less frequent changes in the fuel-feed. This improvement in steam conditions was reflected by all the recording instruments for the unit, including the generator wattmeter. The small and infrequent changes in the rate of fuel feed permitted a closer adjustment of the fuel-air ratio, which improved combustion to an extent that justified installation of a pilot gage to show small changes in drum pressure.

Duluth, Minn. G I SMITH



Multiple-Control Valves Prevent Water-Hammer

INDUSTRIAL AIR-CONDITIONING EQUIPMENT design must take into account varying seasonal heating and cooling demands. During the summer only a small part of the heating coils are needed, a condition that often causes trouble from water hammer in the piping.

Water-hammer difficulties can be eliminated largely by dividing the heater-coil surface into sections and equipping each section with control valves and discharge traps. Control valves can be hand-operated, but if outside temperature is changing rapidly close attention will be necessary for good temperature regulation. On the other hand, diaphragm valves are expensive to put on all heater sections of the system.

Being faced with this problem, we selected what appeared to be the simplest and cheapest method, and used a combination of automatic and hand control (see diagram). With this system we control enough of the coils automatically to take care of the heating needs during the warmer seasons of the year. During the colder months, the hand valves are opened and the sections under automatic control take care of the swings in temperature outside the building.

The diaphragm valves are air controlled and the valves on each heater are adjusted so that they come into service at different pressures. For example, one valve may completely open on air pressure between 0 to 5 lb per sq in., while the other opens on a

Copper-Arc Welding Repairs Waterwheels

WHEN CAST-IRON WATERWHEELS in Seattle, Wash., Lighting Dept hydroelectric plant's pit, they are repaired by welding. Originally, to make these repairs, the pitted areas were chipped out, drilled, tapped and short steel studs screwed into the holes. The areas were then filled by arc welding, using soft-steel electrodes suitable for welding to cast iron, and finished with a layer of stainless steel. The steel deposit was hard, brittle, and cracked, and it was difficult to get a good bond.

These difficulties have been eliminated by using copper electrodes as the filler metal, with a final layer of stainless steel. After the copper filler is deposited by an arc welder, it is peened with an air hammer. The stainless steel is then deposited, using $\frac{3}{16}$-in. rods and depositing about 9 in. of rod on each blade in rotation. After each deposit the metal is peened and cleaned and the welding and peening operation is repeated until the job is completed. When ground, the welded areas present smooth surfaces free from stresses and cracks, see photo. The copper arc is also a time-saver, as the work is done in about one-half the time required by the old method. The waterwheels are 8 ft in diameter and about 150 lb each of copper and stainless rods are used in the average repair job.

Port Blakely, Wash.
MANDUS E BRIDSTON

pressure-range of 4 to 8 lb. We find that this arrangement works very satisfactorily and has eliminated all serious water-hammer trouble.

Lynchburg, Va. O M Roberts

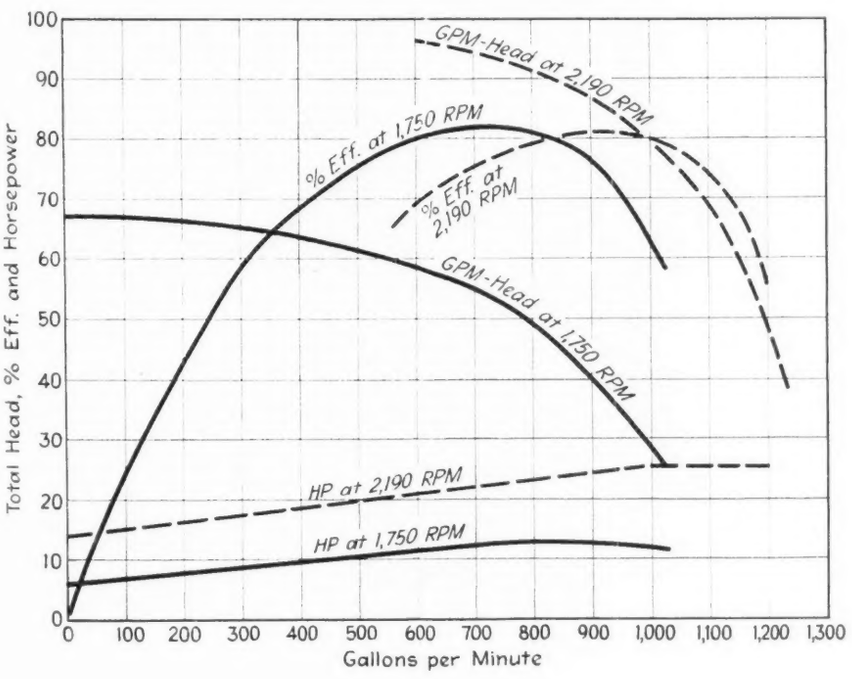
Excessive Speed Causes Pump Troubles

The full-line curves in the figure show the characteristics of a 700-gpm 1750-rpm centrifugal pump operating against a 55-ft total dynamic head driven by a 15-hp dc motor that had been rewound for the job. At rated conditions the pump required 12 hp, but when the motor went into service it acted as if heavily overloaded. In addition the circuit breaker kicked out almost as soon as the motor came up to speed. A check showed that the motor speed was 2190 and not 1750. The dotted curves show how the pump performed at the higher speed and explains cause of the overload.

Centrifugal-pump capacity varies directly as the speed, the head varies as the square of the speed, and the brake-horsepower varies as the cube of the speed. From these ratios it is possible to plot the dotted-line curves to indicate the conditions existing at 2190 rpm. Since the total dynamic head for the installation remained at approximately 55 ft, the pump was actually pumping about 1175 gpm and the power was increased to about 25 hp, which can easily be calculated, by applying the simple rules outlined above.

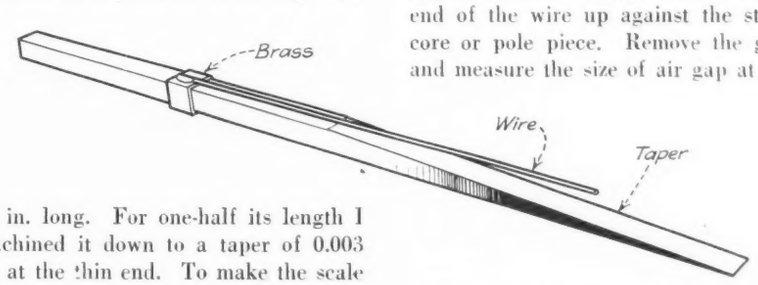
Examination of the motor showed that shims had been omitted from behind the polepieces, making the air gap considerably longer than it should be, and causing a speed increase. Replacing the shims brought the motor back to 1750 rpm, where the unit operated satisfactorily.

New York, N. Y. Frank A Kristal



Self-Registering Air-Gap Gage

The motor air-gap gage shown was made from a piece of $\frac{1}{16}$-in. key steel



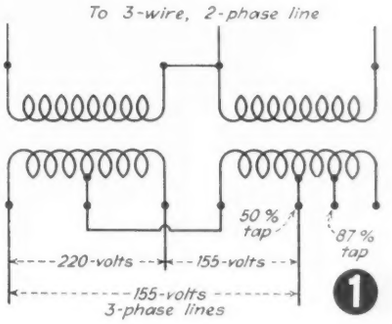
12 in. long. For one-half its length I machined it down to a taper of 0.003 in. at the thin end. To make the scale easy to read, a piece of $\frac{1}{16}$-in. brass was fitted tightly around the large end of the gage. A piece of hard-drawn copper wire about 5 in. long was soldered to this brass.

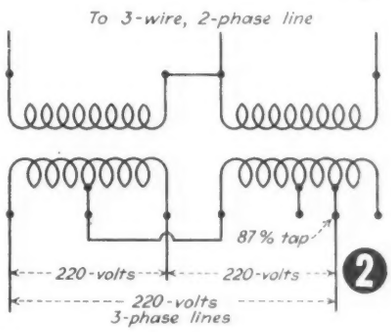
To use the gage, push it into the air gap as far as it will go. Then slide the end of the wire up against the stator core or pole piece. Remove the gage and measure the size of air gap at end of wire with a micrometer. When using this gage be sure to have it between the iron cores of rotor and stator and not in a slot.

Trenton, N. J. R O Cummins

Wrong Connections Unbalance Voltage

Two transformers for changing from 2- to 3-phase power were purchased second hand. After they were installed, motors operated from them had low starting-torque and a tendency to overheat. A trouble man found that one transformer was a standard unit with two high-voltage leads and three low-voltage leads to give 110 or 220 volts. The other unit was similar but also had an 87% voltage-tap brought out for 3-phase (Scott) connection. An error made when the transformers were connected resulted in the 50% voltage tap being used instead of the 87% tap, as in Fig. 1. This gave 155 volts on two of the phases and 220 volts on the other. Connecting the transformers as in Fig. 2 corrected the trouble and gave a balanced voltage on the three lines after which motor starting torque was normal, and it did not operate at an abnormal temperature.





Plainfield, N. J. H W Hodgson

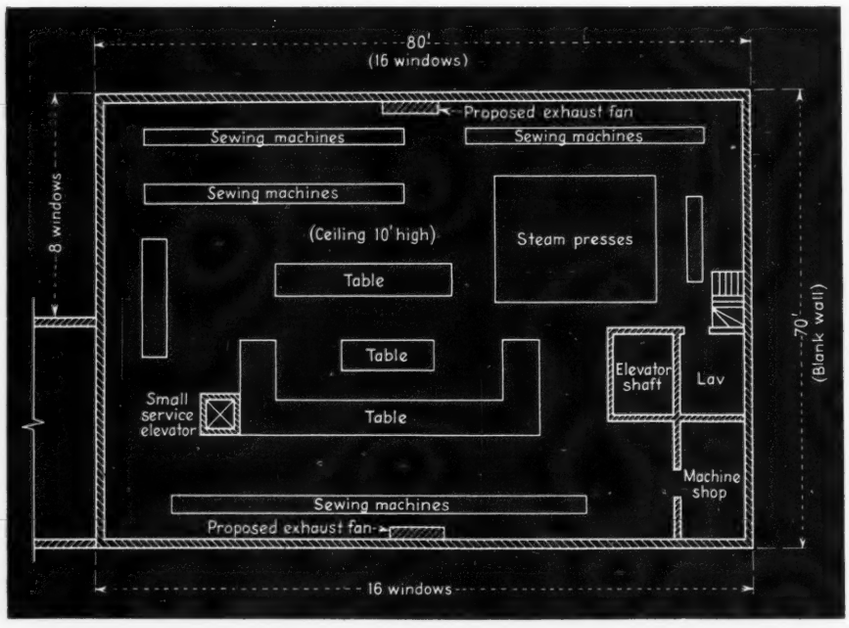
READERS' PROBLEMS

Questions from Our Readers

How to Ventilate?

Question 1

OUR PROBLEM *is one of ventilation. I have attempted to rough sketch a plan of the particular department. There are approximately 100 girls working in this room, as well as eight men operating sewing machines and steam presses. We have attempted to use ordinary blow fans to circulate the air, but they only spread the hot air and steam from the presses. On a normal summer day, about 87 F outside, the temperature in the room will be over 100 F with all windows open. Would it be advisable to install two exhaust fans, one on each side, as indicated in the sketch, or is there a better solution? Perhaps there is some way to control the humidity caused by the steam presses, which cover approximately 300 sq ft of floor space, fairly close to the center of the department.*—GHA.



Pumps Lose Suction

Question 2

WE EXPERIENCE DIFFICULTY *with two 3-in. centrifugal pumps, each direct-driven by 5-hp squirrel-cage, 3-phase motors. The pumps have a common suction and delivery; they fill a remote storage tank at 80 ft head, under control of a single-phase float switch. The water spills into the top of the reservoir for aeration.*

Each pump is equipped with stop valves and the units are intended to operate separately, one acting as standby for the other. The suctions are connected and go straight down through the concrete pumphouse floor in a 3-in. bore-pipe, which had been used for a smaller installation. The suction pipe had to be reduced to 2½ in. and fitted with a vertical check valve which just slides down the bore-pipe. The suction lift is about 18-21 ft.

Each motor has a magnetic starter with a single-phase solenoid operated by the float switch. In addition, each circuit is equipped with a phase-failure, phase-reversal cut-out. The wiring is such that a two-way manual switch can put either set into operation.

Trouble has been encountered through the pump losing the suction in periods of dry weather. They are intended to run unattended except for a weekly visit. It is not practical to dig up the floor, and put down a large bore or well with float control, which would be the simplest solution. I have been considering various alterations for protecting the units and would like to hear what POWER *readers have to suggest.*—ETC.

How to Improve Parallel Pump Operation

Answers to July Question 1

The Question

WE HAVE TWO *duplex packed-piston pumps feeding, under peak load conditions, three boilers. Boilers are equipped with feedwater regulators and the pumps have the usual governors. At a given load, these pumps act all right but as the load changes, one or the other has a tendency to pick up most of the load while the remaining unit makes short fast strokes. What causes this condition and how can we improve parallel operation of these pumps?*—BFD

Suction Restriction

BFD'S REPORT of his difficulties indicates restriction in suction line to the pumps. I suggest he pipe the suction lines individually to the return receiver. With this arrangement, BFD can rest assured that both pumps will do their share in parallel.

Schenectady, N. Y. CARL BACHMANN

Blames Insufficient Flow

MANY PROBABLE CAUSES and remedies might be suggested if BFD had included in his problem some details of suction lift, piping layout, feed temperature, etc, but in their absence we must assume conditions likely to cause the trouble. The statement "one or the other has a tendency to pick up" seems to indicate that the trouble lies in the water end and not in the steam end of these pumps. I believe that there is insufficient flow to these pumps to provide both under load-change demands. This may be due to the suction lift being too great, causing high temperature water to evaporate and thereby causing short-stroking of one pump or the other.

The remedy lies in providing more suction head, by re-arranging piping or by reducing temperature of the suction water. The trouble might also be caused by layout of the suction piping or insufficient pipe area. If filters are used, these may be of the wrong material or may be too dirty.

Kearny, N. J. GEORGE MCNALLY

Try Cooling Water

THE TROUBLE IN BFD's case is caused on the suction side of the pumps, because not enough water is available to supply both pumps. This causes one or the other to short-stroke. The reasons may lie in an undersized suction line, in scale reducing the pipe area, in insufficient suction head for the water temperature, or unequal distribution of water to the pumps. Examination should reveal where the trouble lies. Perhaps if BFD would connect a small cold-water line near the two pumps so as to cool the water entering the pumps, by a small amount, it would help.

Omaha, Neb. P WARD

Need More Suction Head

FROM THE FACTS PRESENTED in BFD's problem, it appears that when the pumps operate under peak load conditions, the units have sufficient suction head so that they fill properly and operate well in parallel. With load change, one of the pumps has a tendency to pick up most of the load while the

other makes short fast strokes. This difficulty results from lack of adequate head to fill the pump end without the liquid flashing, causing the pump to vapor-bind and make short fast strokes until equilibrium is attained and the units probably again operate satisfactorily. This short stroking is no doubt caused by differences in the suction lines, making head on the suctions vary. It is only necessary for flashing to occur in one of the liquid chambers of the duplex unit, since the valve motion of the other chamber is governed by the arm motion of the liquid end in which the flashing occurs. The vapor-bound chamber will have its piston stopped suddenly in its travel and thus its motion arm will cause the other side to short stroke also.

The answer to the problem lies in providing sufficient suction head on the units so that flashing in either unit cannot take place at any of the operating capacities.

East Orange, N. J. R C McDONALD

Purging Ammonia System

Answers to July Question 2

The Question

FOR PURGING *our ammonia system of air, we have a hose connected to the top of an oil trap and into a barrel containing about 30 gal of water. When purging we just crack the purge valve. The water rumbles as when steam is discharged from a hose into water. There is little noise or odor until a fog appears and then there is a cracking sound. Is this method correct? Can* POWER *readers suggest a better method?*—JAC

Not a Modern Method

PURGING AN AMMONIA SYSTEM in this manner seems rather a hit-or-miss method for a modern plant. Why not install an automatic purger as fitted to most plants today? This piece of equipment needs little or no attention and automatically purges air and non-condensable gases from the system, while returning ammonia. Any company handling industrial refrigeration equipment or accessories will be glad to supply literature or give a demonstration of this device which, when installed, can be placed in continuous operation.

If this cannot be obtained and the present method must be continued, I suggest the 30-gal drum be discarded and replaced by a 5-gal glass bottle such as used for distilled water. This bottle, half-filled with water and having the purge line led to the bottom, should be placed in the most convenient location for observation by the operator. In this manner, bubbles of noncondensable gas can be seen rising through the water while an excess of ammonia can be quickly detected and checked. A little practice will show that this method may be regulated to purge the system slowly and continuously for hours or days at a time, as may be necessary.

Kearny, N. J. GEORGE McNALLY

Wastes Ammonia

THE METHOD OF PURGING an ammonia refrigeration system through a small line from the high-pressure gas space, cracking a valve in the line, allowing the gas to discharge into a vessel containing water and assuming that all is well until a crackling sound is heard, is as old as the ice-machine itself. Any attempt to purge a system in this way will be accompanied by a waste of ammonia. It is impossible to purge a system properly by this method and it follows that it will be impossible to keep the head pressure on the system as low as it should be. A law of physics states that "when a plurality of chemically indifferent gases are present in the same vessel they intermingle homogeneously regardless of any difference in their specific weights." It is obvious, therefore, that in the ordinary hand purging a considerable amount of the gas allowed to escape must be ammonia.

A non-condensable-gas purger or a separator should be installed on every ammonia refrigeration system. The general principle of these purgers is to take off the gas from the top of the liquid receiver. The gas enters the bottom of a vessel partially filled with subcooled ammonia liquid. The gas is made to pass through this liquid and, since it is still under high pressure, the ammonia gas condenses and non-condensable gases pass on to the top of the vessel, to be purged off in the ordinary way. It has been the writer's experience that head pressures can be carried about 10 lb lower after purger installation, making considerable power saving. There is no appreciable loss of ammonia in purging with such a device and purging can be done with the machine in operation. The installation of a purger can be justified on all systems of 20 tons or more, in general. In many instances the installation has paid for itself in less than a year.

P C CONSTABLE

McMasterville, Quebec, Canada

How to Check for Air

AIR ENTERS THE REFRIGERATING SYSTEM in various ways, more often around the stuffing box while pumping down the low-pressure side of the system. As the air cannot be condensed at refrigerating-plant pressures, it remains as a gas, causing excessive head pressure. When the plant is in operation, the air in the system is discharged to the condensers along with the ammonia gas, and on into the liquid receiver where it collects at the top, above the liquid level. If the system is purged by hand, it is necessary to pump-down the low-pressure side, including the evaporating coils and direct-expansion piping. Then shut down the compressor. Keep the condensing water running so that all gas will be condensed, thus giving the air a chance to work its way up to the highest point in the condenser. After the compressor has been shut

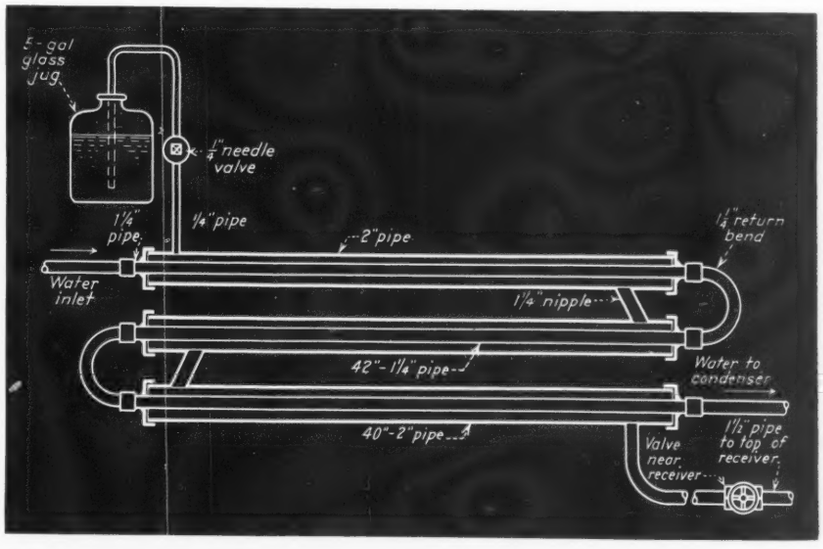
Solved Similar Problem

JAC'S QUESTION IS SIMILAR to one we solved two years ago, with excellent results. We were losing ammonia, plus a full day's refrigeration, in purging by the method JAC describes. We made a continuous purge coil, using 1¼-in. and 2-in. pipe, and 1¼-in. return bends, assembled as in the sketch. The coil was installed just ahead of our double-pipe condenser and required no additional water. The air is purged from the top of the coil through a 1¼-in. pipe and needle valve into a 5-gal glass jug, and can be adjusted to give as little as one bubble per minute.

The water flowing through the 1¼-in. inner pipe condenses any ammonia gas carried by the air, and the ammonia flows back to the receiver. If at any time the system is completely cleared of air, the purge valve may be closed until needed again. Ammonia loss under this system is negligible compared with losses caused by running a system with air in it.

I should add that all pipe used in the coil was extra-heavy and all joints were welded. It is important to keep all drainage from the coil toward the receiver by pitching these pipes so that the flow is in the proper direction.

Syracuse, N. Y. W W JONES



down for an hour or so, you can make a check on the amount of air in the system by use of the ammonia tables. For instance, if the water is at 70 F and no air is present, the pressure should be 114 lb, but if the pressure on the condenser gage reads 150 lb, the difference would be caused by air pressure.

Omaha, Neb. J R Addison

Purge from Coolest Point

My first recommendation would be the installation of an automatic purger, but if it is out of the question to install one of these low-cost devices, purging should be done from the coolest point on the high side of the system. This point will vary with load and cooling-water conditions. If the plant has an atmospheric cooling tower, a sharp increase in air temperature will result in a rise in cooling-water temperature and in the liquid-ammonia temperature. Under these circumstances, the liquid in the receiver will be cooler than the incoming liquid from the condenser. Air will then accumulate in the receiver, which will be the cool point on the high-side. When outside temperature is falling, conditions will be reversed and the condenser temperature will be lower than the receiver temperature. Then there will be a backflow of gas from receiver to condenser. This backflow will carry air from the receiver so that air will be found at the cold end of the condenser.

At best, manual purging is bound to be expensive. If the high-side contains 5% air by volume, for every cu ft of air discharged, 19 cu ft of refrigerant gas will be wasted. By lowering the temperature of the air-refrigerant-gas mixture to the suction temperature, this ratio will be reversed, in that the volume of air discharged to atmosphere will exceed the volume of refrigerant lost. With 150-lb high-side pressure and a suction temperature of 0 F, 107 cu ft of air can be removed with loss of only one lb of ammonia.

Three Rivers, Mich. T H Rea

Purging Arrangements Depend on Layout

The proper method of purging air or other non-condensable gases from a refrigeration system depends to a great extent upon design and method of operation of the system to be purged. If it is between the compressor and condenser, the oil trap is the proper place from which to purge, only if it is the highest part of the system. Such an arrangement is likely to be found in plants using a double-pipe or horizontal shell-and-tube condenser set at floor level. The oil trap is not likely to be higher in systems using atmospheric or vertical shell-and-tube condensers, as the former are usually on the plant roof and the latter are usually of such height as to extend much of their gas volume above the convenient level for the oil trap.

Except in cases where the oil trap is above the highest part of the condenser, purging is best carried out from the highest part of the condenser, whatever its type, or from the gas space of the liquid receiver, whether this vessel is vertical or horizontal. Purging from the condenser should be carried out while the compressors are idle, as agitation of the gases by the incoming superheated vapor from the compressors will keep the mass turbulent, and result in loss of much refrigerant. Purging from the gas space of the receiver should be carried out while the compressors are operating, as the constant flow of vapor will keep the condenser full of pure refrigerant and the non-condensable gases will be forced through the equalizer line into the receiver.

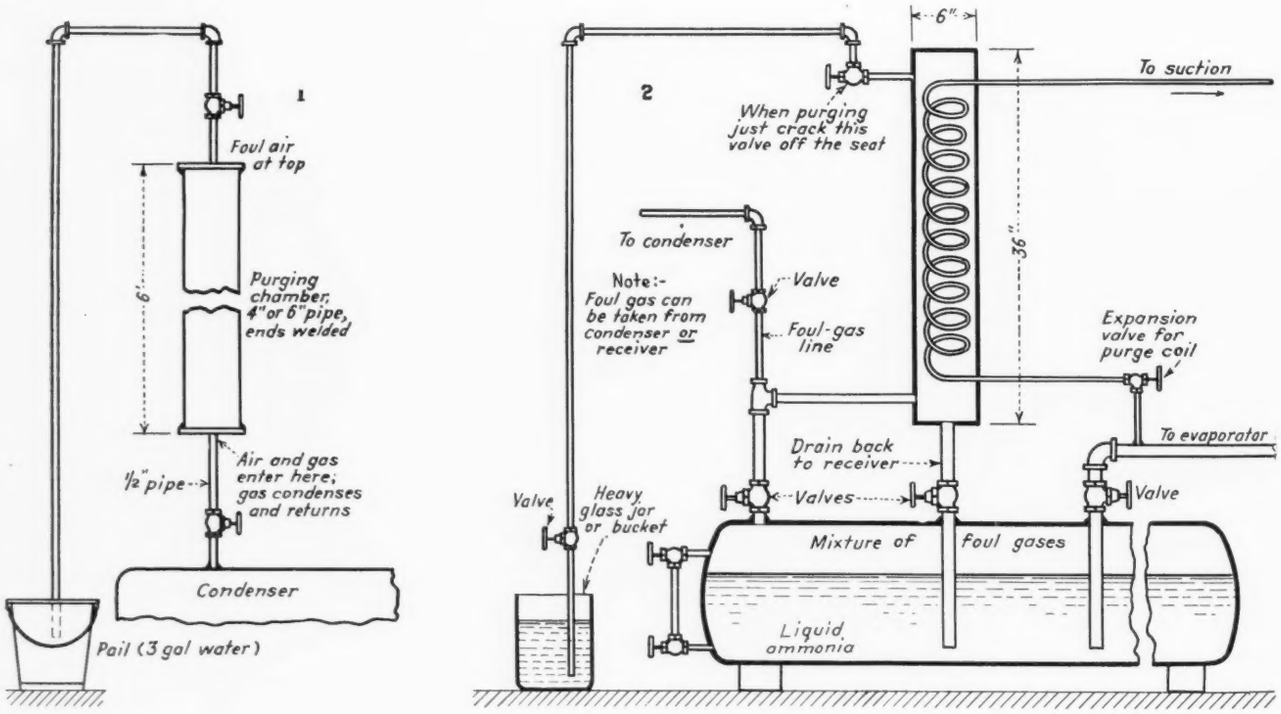
Purging should take place slowly, but not too slowly, to permit the newly evaporated vapor from the liquid in the lower part of the condenser or receiver to diffuse upward and be expelled from the system with the purged gases. Check should be kept on the

Home-made Purger

By using an inefficient method, JAC is drawing ammonia gas as well as air out of the system. The diagram shows a home-made, hand-operated purger that can be built simply and cheaply. The 6x36-in. purge tank should be of extra-heavy pipe because it has to stand condenser pressure. It would be a good idea to insulate it with a good grade of material. If a glass jar is used for the condensed air to bubble through, a light can be placed on one side and the air bubbles can be seen easily from a distance. A 1-gal jar or bucket will be large enough for the average plant. When large bubbles no longer appear from the air discharge pipe and a cracking sound is heard, the purger should be shut off.

If the receiver is in the engine room or near the compressor, the top of the receiver would be about the easiest and cheapest point of connection for the foul-gas line. It is good practice to connect the foul-gas line to the highest point in the system, which is usually the condenser. However, it is my opinion that the air circulates in the system and will not pocket in any definite place, providing the setup is not at fault. I have found from experience that installing the whole purger on top of the receiver and taking the foul gas therefrom makes an efficient installation. I have come within two lb of theoretical pressure corresponding to the condenser-water temperature.

Fort Thomas, Ky. W H Harvey



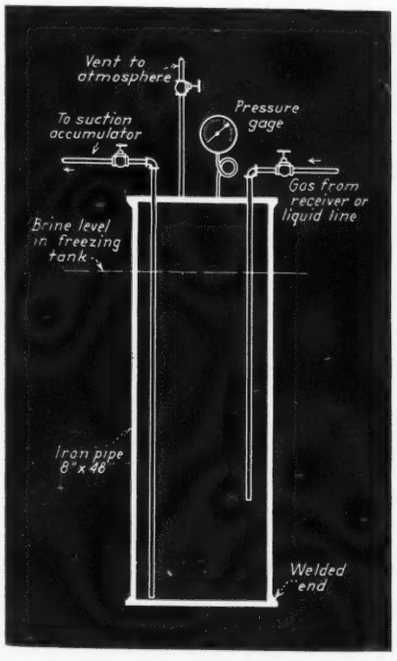
actual gage pressure and the pressure corresponding to the temperature of the liquid leaving the condenser. For instance, if the temperature of the liquid leaving the condenser is 80 F and is not sub-cooled (at about the same temperature as the condensing water), the gage pressure should be 140 lbs with the compressors idle, or somewhat above this point if they are operating. Should the gage show a pressure of 180 lbs while the liquid from the condenser is at a temperature of 80 F, then there is 40 lb air pressure in the system. To reduce refrigerant loss in purging, condensing water should be as cold as possible. Superficially, the object of purging is to bring the indicated temperature on the gage down to, or nearly to, the temperature indicated by a thermometer placed in a well in the liquid line from the condenser.

In purging, the water solvent should be measured or weighed into a glass jug or bottle. The jug or bottle should be three-fourths full at the start, with the purge hose or connections well submerged in the liquid. A check on the efficiency of the operation may then be made easily. If a great number of air bubbles rise in the bottle, and little heat is generated, purging is effective. If there is much sputtering and few air bubbles, accompanied by much heating of the bottle, purging is either ineffective or complete, and in either case should be discontinued. By weighing the bottle and liquid contents before and after purging, loss of refrigerant and cost of making the purge may be determined.

Marissa, Illinois GEORGE BLUM

Simple Hand Purger

USUALLY THE TOP OF THE OIL TRAP is not the proper place to purge; the connection should be made at the top of the condenser. The system should be shut down and condensing water should be allowed to flow for 2 to 5 hr over the section to be purged, to allow the ammonia to condense and the gas to separate from the liquid ammonia.



The purge valve should then be opened slightly. As long as the non-condensable gases are passing into the water, it will simply bubble, but as soon as ammonia comes into the water, a crackling is produced, which is similar to the sound of steam being introduced into water, and the purge valve should be closed. After a few minutes the process should be repeated.

In taking foreign gas from the system, the question may rise as to whether there is enough coming out to justify leaving the gas valve open. This is the way I have settled the question: take a quart milk bottle and fill it with water. With the open end submerged in the bucket of water, invert it and hold it in this position. At the same time insert the end of the foreign-gas hose in the end of the inverted bottle. Some idea of the amount of air and non-condensable gases coming out may be obtained by taking note of the rapidity with which the bottle empties of water.

If you want to purge the plant while it is in operation, a connection should be made on the liquid line between the condenser and receiver. The sketch shows an inexpensive foreign-gas remover that can be operated by hand while the plant is in operation. Simply immerse this purger in a corner of the brine or freezing tank. Open the valve from the receiver and when the gage pressure equals condenser pressure, shut off the purger and let it stand until pressure drops from the cooling effect of the brine. Blow non-condensable gas to atmosphere and then open to the suction accumulators and draw back into the system what is left in the purger.

Hamilton, Ontario, Canada I S ELLIOTT

Oil Trap May Be Highest Point

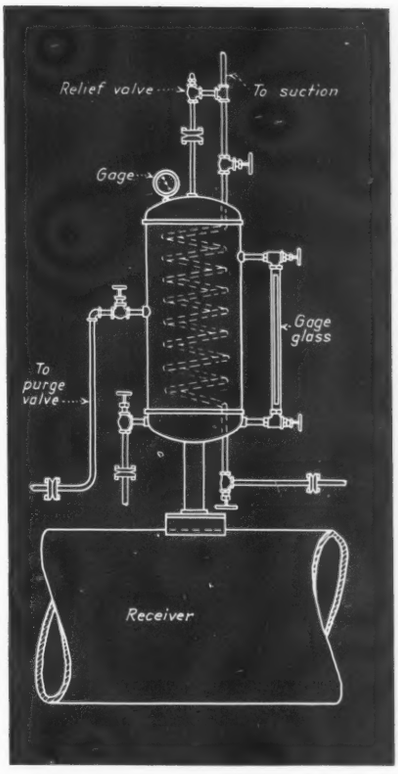
REFRIGERATION BOOKS USUALLY RECOMMEND air purging from the top of the condenser. This can be done with least loss of ammonia after shutting down and cooling the condenser as much as possible. However, if no crackling occurs while the air is bubbling through the water, JAC's method is effective, since the crackling is caused by the sudden absorption of ammonia in the water. In a plant I once operated, the top of the oil trap was the highest point between the compressor and the receiver. We purged from this connection with satisfactory results.

Toledo, Ohio FRANK IRWIN

Buy Automatic Purger

AIR AND INERT GASES in a refrigerating system are carried along with the ammonia during the cycle. When they reach the condenser and liquid receiver, they usually remain there. That which collects in the condenser may be removed by a hose as JAC suggests. The air causes the water to rumble and the cracking noise is caused by the sudden and complete absorption of the ammonia in the water. Best results are obtained when the system is shut down and the condenser has cooled.

Several devices are on the market to purge the receivers as well as the condensers, without loss of ammonia. The one illustrated by the diagram seems simple and economical. It condenses most of the ammonia vapor and allows it to be returned to the receiver.



Lakewood, Ohio J P SIMONS

When to Purge

THE PRESENCE OF NON-CONDENSABLE GASES in the condenser accounts for the unusually high pressure in most cases. Ordinarily, the pressure will be such that the temperature of the ammonia in the liquefying portion will be 5 to 10 F above temperature of water leaving the condenser. The temperature of the condenser water may be determined, and by adding 5 to 10 degrees to this, the temperature of the saturated ammonia may be obtained. Then by reference to a table of the properties of saturated ammonia the corresponding pressure may be ascertained. The operator can then compare this with the actual pressure and note the difference. The condenser pressure that should be obtained under ordinary conditions while the plant is in operation is shown by the following table with various initial temperatures of the condenser water:

Initial Temp of Condenser Water, F	Condenser Gage Pressure, Lb per Sq In.
50	120
60	140
70	160
80	180
90	200

The pressures indicated in this table are considered good practice. If actual pressures are materially above those indicated in the foregoing table, the operator should suspect the presence of non-condensable gases in the condenser and should proceed

(*Continued on page 150*)

How Heat Moves

By PHIL SWAIN

WHERE THERE'S HEAT FLOW there is generally a job for the engineer, helping the heat flow where it should and preventing flow in the wrong direction (by insulation).

Physicists agree that heat moves in three ways only—by conduction, by convection, and by radiation.

Conduction

Conduction is a leisurely process like the trickling of water down a hillside. If you heat one end of an iron rod, it may be minutes before you notice the rising temperature at the other. According to the so-called "kinetic theory", heat is conducted through matter by a series of kicks or pushes. High-temperature molecules move fast; low-temperature molecules move slowly. When you heat one end of the iron rod the molecules there move faster, and bump those next in line into faster motion, and so on down the rod, as in Fig. 1.

Conduction, then, is heat-transmission by the mechanical bumping of one particle on the next. This applies to liquids and gases also, but there's a difference in the way the molecules act. In a solid the molecule swings around its home base, like a grazing horse wandering around on the end of a tether.

In a liquid the molecules have more freedom—wander around gradually from one place to another, but are never completely free from their fellow molecules—a good deal like a man dodging through a circus crowd.

In a gas the molecules shoot around freely, like bullets flying in open space. Each keeps going in one direction until it strikes another, then caroms off like a billiard ball.

In all three cases, despite these differences, heat conduction is by bumps alone. However, in liquids and gases some of the heat transfer always will be by convection and radiation. That's why it is often so hard to tell what fraction of the observed heat transfer is by each method. For example, when you stand some distance from a room radiator you are heated to a substantial degree by both radiation and convection, and to a very slight degree by conduction through the air.

Convection

You might call convection "slow freight or express". Convection applies only to fluids (liquids and gases). Heat carried by convection is that carried by the actual movement of the substance. It is simple mechanical transportation, nothing else. The fluid movement may be "natural" (caused by so-called thermal currents) or it may be "forced circulation" (as by a fan). In either case the gas or liquid moves up to a hot surface, is heated, and moves away to a cooler spot where it dumps its load of heat.

Radiation

I call radiation "radio broadcasting" with good scientific excuse. Radiant heat travels out in a straight line with a speed of 186,000 miles per sec, exactly the same as light and radio waves.

Naturally you can't measure this 670 million miles-per-hour speed without special instruments, but any engineer can satisfy himself that radiant heat moves very fast by the simple test illustrated in Fig. 3. The ordinary electric heater sends out most of its heat by radiation, with the speed of light. Have a helper slip a large card across the face of the heater. The instant he does so you will feel coolness—no waiting.

While I am on this subject of radiation, I should make it clear that all bodies radiate heat. Even a cake of ice placed near a steam radiator radiates heat to the radiator. Meanwhile, the radiator sends far more heat to the ice, so there is a net transfer of heat from the radiator to the ice, causing the ice to melt.

Radiation figuring is a bit complicated. The basic law is that each body radiates in proportion to the "fourth power" of its absolute temperature. Thus if the absolute temperature is doubled, its radiation will be sixteen times as great ($2 \times 2 \times 2 \times 2 = 16$)

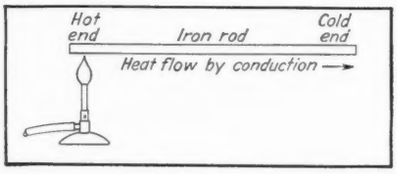
Because of this fourth-power effect, radiation piles up faster and faster as the temperature rises. When you are standing near a warm body you receive heat partly by convection and partly by radiation. If the temperature is moderate with good air currents, most of the heat may come by convection. If temperature is very high, as with a white-hot billet, most of the heat will come by radiation.

Convected heat requires air, water or some other fluid for its transmission. Radiant heat will go perfectly through a vacuum. For example, the radiant heat of the sun travels 98 million miles through vacuum to the earth in eight minutes.

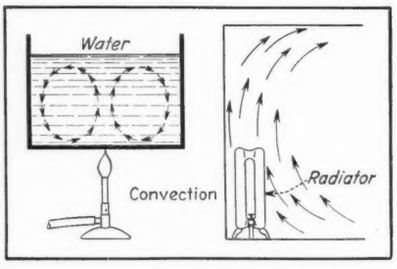
Now back to conduction in more detail: The flow of heat by conduction is like the flow of electricity from a higher potential to a lower. After conditions get steady, heat conduction follows a law exactly like Ohm's law in electricity, as the following will show.

Ohm's law says that electrical flow (amperes) equals pressure (volts) divided by resistance (ohms). Heat conduction law says that heat flow through a body by conduction equals the temperature-difference between the hot and cold sides, divided by the heat resistance. If you double the temperature difference, heat will flow twice as fast. If you double the resistance, heat-flow will be cut in half.

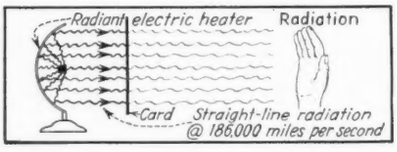
Next month this page will show how to figure a few simple problems in heat transfer.



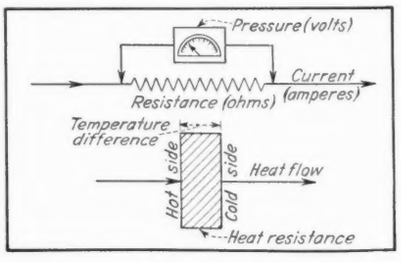
1—Conduction is "trickling down hill". Heat flows gradually from hot end of iron to cold end



2—Convection carries heat by actual movement of water, air or other fluid. In "natural-circulation" convection (here shown) the heat itself sets up the fluid currents. Fans are used for "forced-circulation" convection



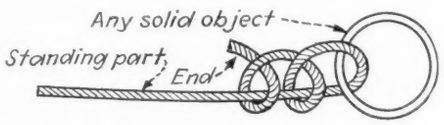
3—Radiant heat is like radio waves and light waves. Card will cut off heat at hand in less than one millionth of a second



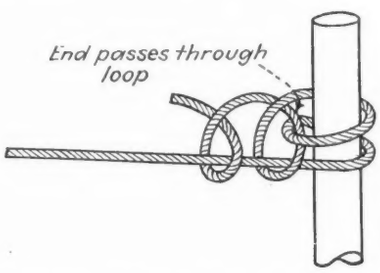
4—Heat conduction follows same law as steady electrical flow: Flow equals difference in voltage (temperature difference) divided by resistance

HOW TO MAKE HITCHES

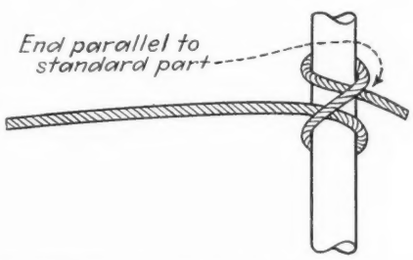
FASTENING ONE ROPE to another is accomplished by tying a knot; fastening a rope to a post, ring, hook or any other object is done by making a "hitch." Hitches are used for special purposes more than knots, hence many are known by the job they have to do. Many hitches developed especially for sailing ships are omitted here in favor of others of particular use in putting up scaffolds or in general applications about the power plant. Data and diagrams by W Elwood Rossnagel, safety engineer, Consolidated Edison Co of New York.



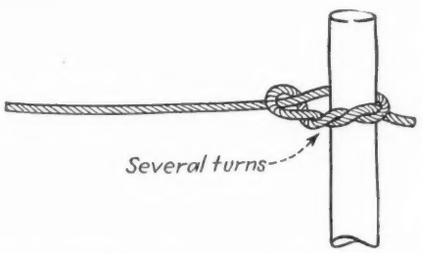
1 **TWO HALF HITCHES—Simplest hitch is made by passing a rope around any anchorage then back around itself twice**



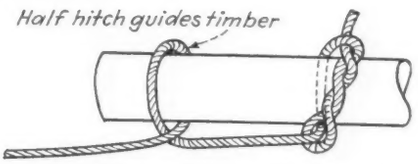
2 **FISHERMAN'S BEND—Much like two half hitches, this one is tied by making an additional turn about the anchorage and passing the first half hitch through this turn. Will not work loose even under jerky or intermittent loads. Also called "anchor knot" or "bucket hitch"**



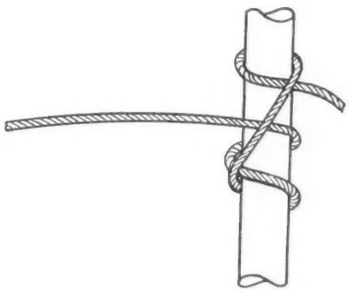
3 **CLOVE HITCH—Two half hitches on the anchorage instead of on the rope itself, can be tied quickly, will remain tight and can be easily loosened by pulling either end toward the other. An added half hitch around the standing part of the rope keeps hitch tight against pull from any direction**



4 **TIMBER HITCH—When the pull is parallel with pole or pipe, several turns about the bight make a hitch that is tied and loosened more quickly and easily than the clove hitch**

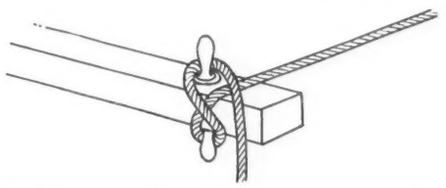


5 **TIMBER HITCH AND HALF HITCH—To guide long material while hoisting, a half hitch is taken some distance from the timber hitch**

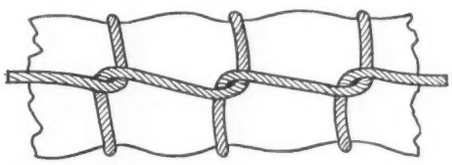


6 **MOORING KNOT—Sometimes called the rolling hitch, this is similar to a clove hitch but with an additional turn around the anchorage in the first half of the knot. If the standing part is pulled, the hitch jams on the pole but if the strain is relieved the entire hitch will slide**

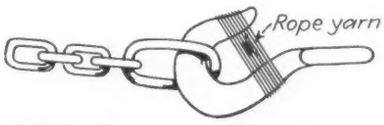
7 **STRAP—Made by wrapping a smaller rope about a larger cable or pipe; intended for longitudinal pull**



8 **BELAYING PIN HITCH—Several turns about a pin or cleat fasten rope under constant tension. As shown, this hitch is unwound rather than untied, so that the rope can be loosened quickly under tension. A half hitch over one end of the pin makes the fastening permanent**

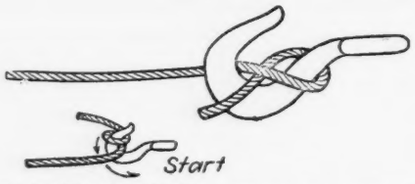


9 **MARLIN HITCH—Successive half hitches spaced as needed to bundle up a tarpaulin**

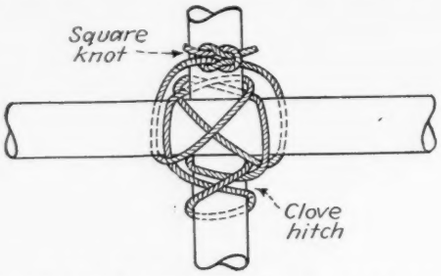


10 **MOUSING—Many an accident has resulted from a hook being unintentionally detached from the load. A number of wraps of small cord or rope yarn taken around the hook prevent slipping, but be careful the load bears on the hook rather than the mousing**

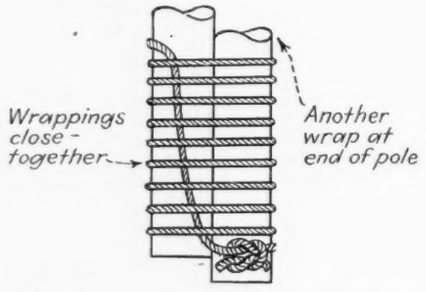
HOW TO MAKE HITCHES



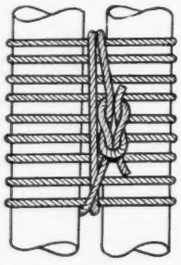
11 BLACKWALL HITCH—Wrap the rope one and a half times around the hook and slide the loop up the neck for temporary attachment and steady pull



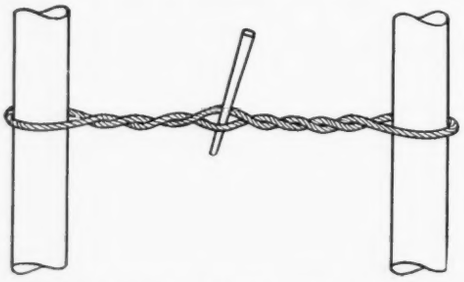
12 POLE AND LEDGER LASHING—Lashing two pipes or poles at right angles starts with a clove hitch and ends with a square knot



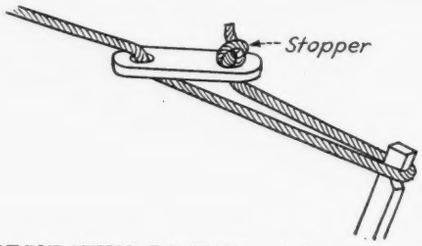
13 POLE LASHING—Where two poles are parallel, two sets of close-wrapped rope like that shown should be used, one near the end of each pole



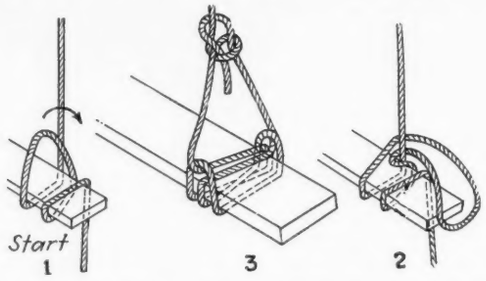
14 PORTUGESE KNOT—This lashing tightens automatically when poles spread to make an "A" frame



15 SPANISH WINDLASS—A stick or pipe inserted in an endless rope about two objects can exert a powerful force for drawing them together

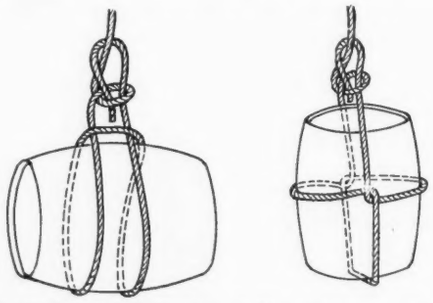


16 REGULATING LASHING—A board or steel strap with two drilled holes makes a conveniently adjusted guy or temporary rigging

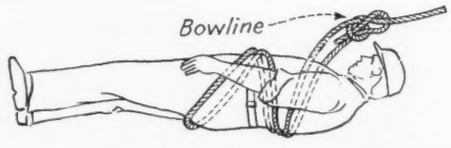


17 SCAFFOLD HITCH—A single-plank scaffold will stay on an even keel if two turns are taken around the plank, the first loose turn passed around the supporting rope and over the end of the plank and the end of the rope brought up to form a bowline

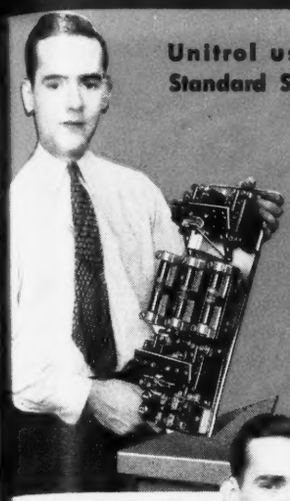
18 BACK HITCH—To secure the hauling rope of a set of falls to a swinging scaffold, bring a bight of the rope under the inverted "V" of the steel stirrup and give a full twist over the bill of the hook. To be secure, the ropes must cross exactly in the crotch of the stirrup



19 BARREL HITCH—Unwieldy objects can be hoisted with variations of the ever-useful bowline



20 SAFETY SLING—Teach your working mate this one for your own self preservation. The doubled rope forms a chair, then is crossed twice over abdomen and under shoulder blades. The rope end forms a bowline after passing forward under armpits. Comfortable, as well as safe



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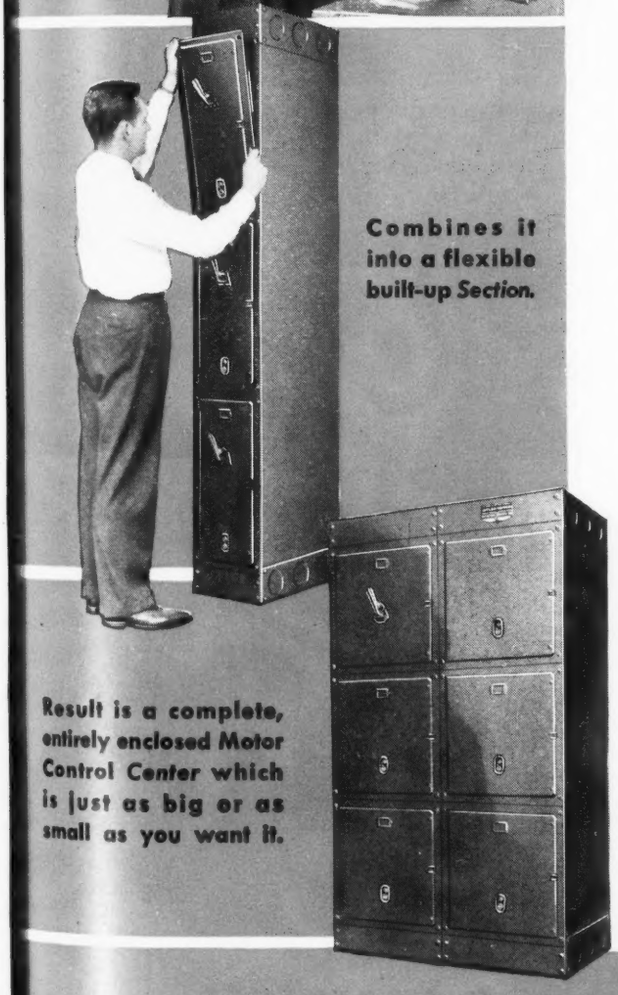

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Sagging Boilers Go Straight

When one corner of the foundation under two boilers and accessories settled 14 inches, the call was for re-alignment without dismantling, to avoid interference with defense production. J H Lym, of Lym Engrg Co, Salt Lake City, gives a blow-by-blow description of the straightening job

▶ DURING THE PAST YEAR, our company built the steam-plant equipment for the new factory, at Spanish Fork, Utah, of the Gold Medal Div, Illinois Powder Mfg Co. of St. Louis, Mo. We set our equipment, including two 3300-sq-ft Stirling watertube boilers, steel stack, and necessary auxiliaries, on foundations provided by the general contractor. Total weight came to 800 tons.

In the exceptionally wet spring just past, water accumulating from the hillside thoroughly saturated a substantial portion of the plant grounds around the supply warehouses and power house. When the recent earthquake occurred in Mexico, the tremor traveled through this area, and, although slight, was definitely recorded on the seismograph at the University. This tremor may not have been the cause, but at the time of the recordings an underground earth movement began which eventually involved an area about 75 ft wide and 1500 ft long. The corners of two warehouses and the power house dropped about 14 in.

We immediately set up a temporary marine boiler (2500 sq ft) to keep steam up while repairs were made to the plant. At the same time, a test hole made outside the plant showed that the foundations had been built on 6 ft of compact clay over 10 ft of silt, clay and quicksand, resting on about 50 ft of coarse gravel, partially cemented. With this information we were ready to contract to re-align the boilers without dismantling, which would have seriously delayed production.

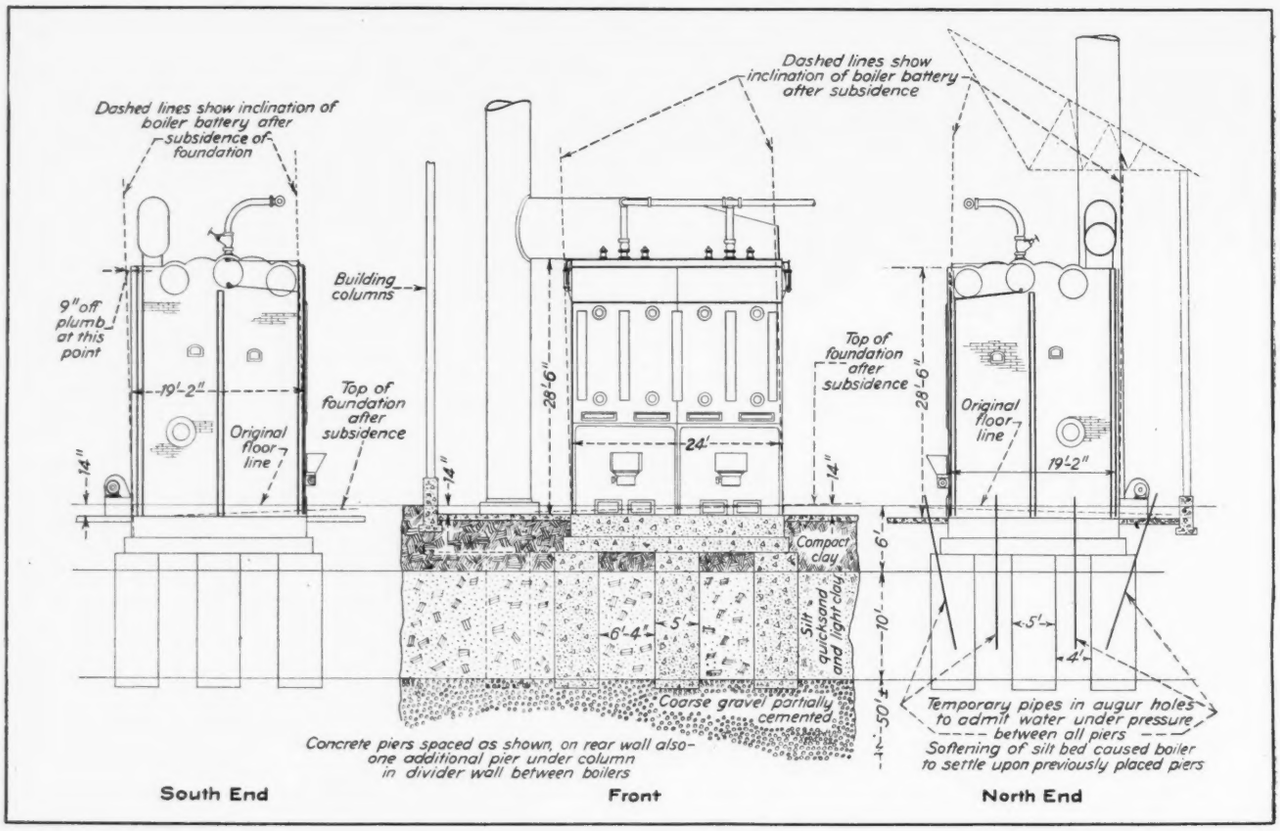
We first excavated under the lowest corner of the power house 16 ft below the original floor level. We then placed a 5-ft-square concrete pier and tied this corner solidly to the pier. From this point we worked at each corner, one at a time, compensating for elevation differentials. As can be seen in the drawing below, we poured a total of nine piers, about 100 cu yd of new concrete.

Leveling Process

To level the foundation, we bored an auger hole between each pair of piers to 2 ft above the gravel bed. Through pipes placed in these holes, we applied water under pressure, to soften the quicksand and clay formation. This gradual lowering-process required six days to complete.

We have been on the job six weeks and the walls are all plumb, with original concrete mat under the foundations now permanently resting on the piers. After the first 3-day shutdown the plant has continued in operation.

Foundation and equipment drawings show extent of settling and steps taken to cure the trouble


Dashed lines show inclination of boiler battery after subsidence of foundation
Dashed lines show inclination of boiler battery after subsidence
9" off plumb at this point
Building columns
19'-2"
Original floor line
Top of foundation after subsidence
14"
28'-6"
24'
Top of foundation after subsidence
Original floor line
19'-2"
Compact clay
Silt, quicksand and light clay
6'-4"
5'
6'
10'
50'
5'
4'
Coarse gravel partially cemented
Concrete piers spaced as shown, on rear wall also one additional pier under column in divider wall between boilers
Temporary pipes in augur holes to admit water under pressure between all piers
Softening of silt bed caused boiler to settle upon previously placed piers
South End
Front
North End

World's Largest Recycling Plant Uses Yarway Impulse Traps

AT the Coastal Recycling Company Plant at Corpus Christi, Texas, said to be the largest plant of its kind in the world, Yarway Impulse Traps are in use on gas heaters (illustrated), steam mains and other equipment, both indoors and outside exposed to the elements.

Yarway Traps are replacing less efficient, less dependable devices on important equipment in many plants. More than 100,000 have been purchased.

Why? Because the Yarway is the one trap that meets all these requirements:—*High Efficiency*—with continuous discharge on heavy condensate loads, and intermittent discharge on light loads; *Good For All Pressures* within wide range without change of valve or seat; *Simple Design*—easy to maintain; *Small Size, Light Weight, Straight Through Piping*—facilitating installation, saving space; *Low Price*—often making it cheaper to install a new Yarway than to repair an ordinary trap.

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Questions for Operating Engineers

Questions on pressure vessels form an important part of many license examinations—here are some typical problems, with answers by Harry Spring

Q—*What is an "explosion disk" and for what are such objects used?*

A—Before describing "explosion" or "rupture" disks, it might be of interest to POWER readers not familiar with the Pennsylvania Regulations for Unfired Pressure Vessels to quote Rule UE-10: "Rupture disks or heads may be used for additional protection of pressure vessels but they shall be designed to fail at a pressure above the safety- or relief-valve setting." Fig. 1 shows a typical rupture disk or safety-head diaphragm. The device consists of a pair of special clamping flanges holding a preformed rupture diaphragm. These diaphragms are carefully made and have been proved by test to burst within 5% of the specified pressure, at normal operating temperatures.

As in the case of a safety or relief valve, the disk is designed to prevent excessive pressure from building up in a vessel. The rupture disk, while considered by the Pennsylvania Code as supplementary to a safety or relief valve, performs two distinct services not obtainable with the typical pop safety valve. First, it is designed to protect the vessel against excessive pressure from internal combustion explosions. Combustion of the vessel's contents may propagate flame and generate heat at such a rate that the pressure rise is too fast for a pop safety valve to handle. In this case, the rupture disk bursts wide open and relieves the pressure quickly.

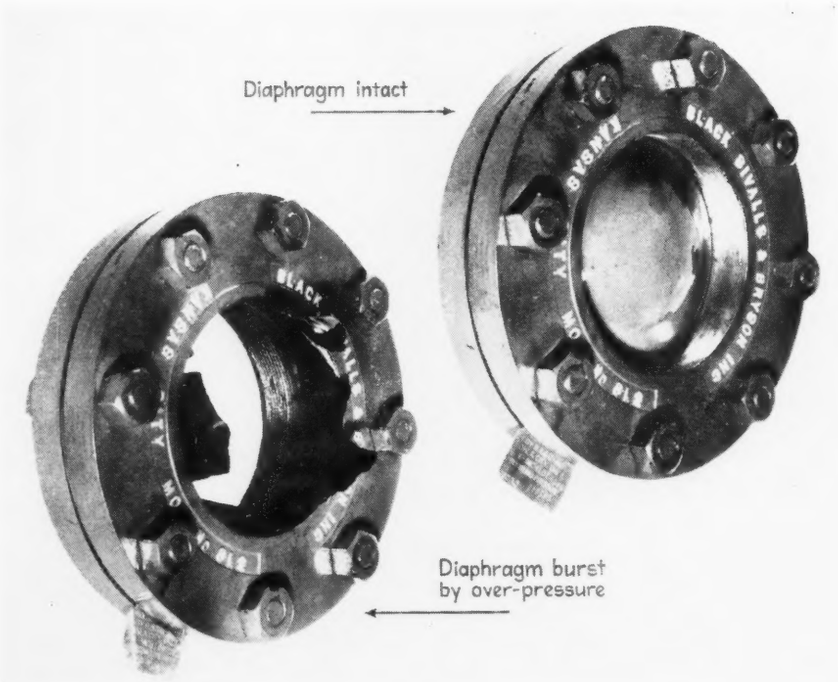


Fig. 1—Typical "explosion" or "rupture" disk

Fig. 2—Typical diaphragm relief valve

The second feature of the rupture diaphragm is that it may be made of a wide variety of corrosion-resistant materials such as aluminum, copper, monel, nickel, platinum, gold, silver, and stainless steel, as well as so-called carbon steel. Also the diaphragms may be coated with lead, latex, bakelite, neoprene or similar materials. Thus the device lends itself admirably to chemical vessels containing corrosive substances.

Q—*Why does the Pennsylvania Code covering unfired pressure vessels require "diaphragm valves" on hot-water tanks instead of the regulation spring-loaded safety valve?*

A—Diaphragm relief valves, similar to the one shown in Fig. 2, are used on hot-water tanks instead of pop safety valves because water is practically incompressible. If a pop valve were used, the blow-back feature might cause the valve to remain open for a long time after "popping." The diaphragm valve is highly sensitive and after relieving a slight over-pressure, it closes. This is all that is necessary, as it is not normal for pressure in a hot-water tank to rise rapidly as it might, and does, in a steam boiler.

Q—*How is the limit of safety determined for a pressure-vessel head made of cast iron?*

A—If the heads are to be made of cast iron, there is no accepted formula whereby the *maximum safe pressure* may be calculated directly. There are a number of empirical formulas, but the results differ considerably and their application is not entirely satisfactory. Then, too, cast iron may be quite variable in quality.

(Ed Note—Additional questions and answers on pressure vessels by H M Spring will appear in future issues of POWER.)

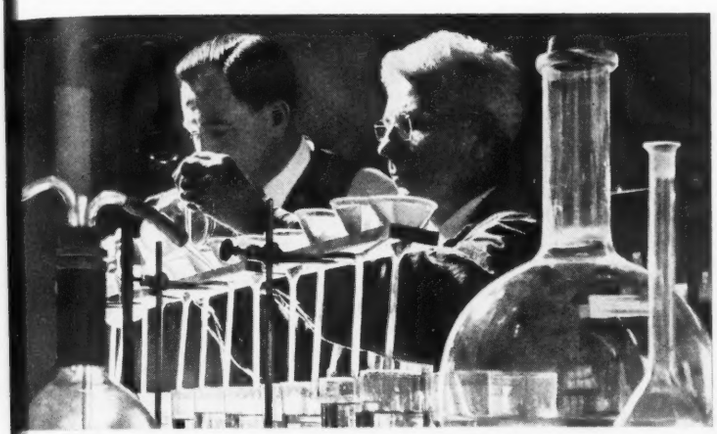
TWO YEARS LONGER TUBE LIFE

FOR STATION No. 4

. . . Scovill's 3-Way Condenser Tube Service May Get You Similar Results

Tube deterioration was swift at Station No. 4. Was another tube alloy the answer? A minor mechanical change? Or was Scovill's Laboratory already on the way to an answer through its constant research and development of alloys?

Pictures on this page show how Scovill's three services . . . in *men, metals* and *manuals* . . . go into action to solve customers' condenser tube problems.



MEN—At Station No. 4, tube deterioration had set in very rapidly on the outside of the tubes near the tube sheet. Tube samples were thoroughly studied at Scovill's Laboratory. Tests proved nothing wrong with the present alloy, but a change in tube installation was recommended and acted upon. Service life has been very satisfactory ever since.

MANUALS—The installation method so successfully applied in the situation above . . . and important data on all Scovill's tube material are contained in a new "Condenser Tubes" booklet . . . free for the asking and part of Scovill's Service in Manuals. Write Scovill Manufacturing Company, 13 Mill St., Waterbury, Conn.

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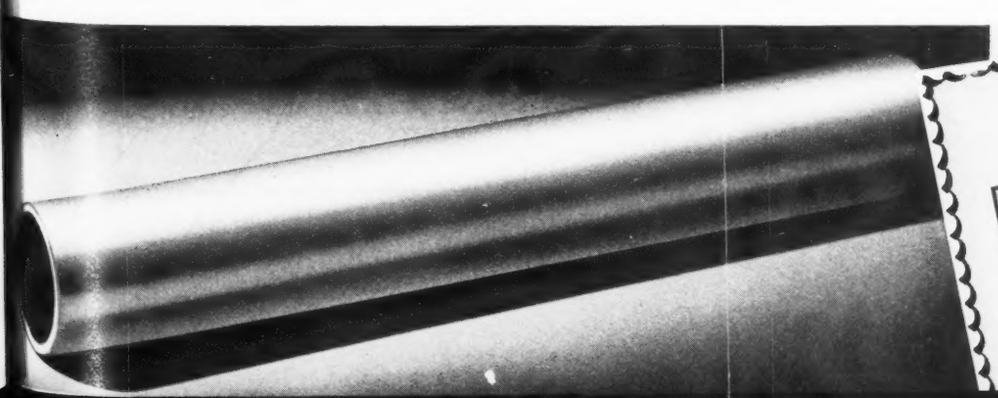

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How to Make Arc-Welded Steel Cylinder-Heads

Floyd E Ford, Natural Gas Pipeline Co of America, describes an all-welded design, using rolled and forged plates, developed to replace cracked cast-iron heads on 1250-hp engines*

► STEEL OFFERS many advantages over cast-iron for cylinder heads on internal-combustion engines, particularly if rolled or forged parts can be used in place of castings. Welding makes possible use of rolled shapes and forgings; this article describes design and method of assembly of an arc-welded steel head.

In this case, since the welded head was to be used as a replacement for a cracked cast-iron head, it was necessary to maintain the same dimensions and general shape. In adapting welded fabrication to a new engine design, a simpler design probably could be worked out. For this particular job, all parts were made from low-carbon steel. The material should have a tensile strength of 45,000 to 55,000 psi and should bend 90 deg. All welding was done by the shielded-arc process, with heavily coated electrodes.

The general assembly of the parts is shown in the working drawing; these parts are made up as follows:

A—Base plate of 1½-in. material

B—Outer wall of ¾-in. tubular materterial of proper diameter

C—Forged cap or dome, ¾ in. thick

D—Heavy forged swage; ¾ in. thick at small end, ⅝ in. in main body. (This part could be made by welding, if desired)

E—Ring of 1 x 3-in. material, 32-in. in diameter, for adapting head to cylinder

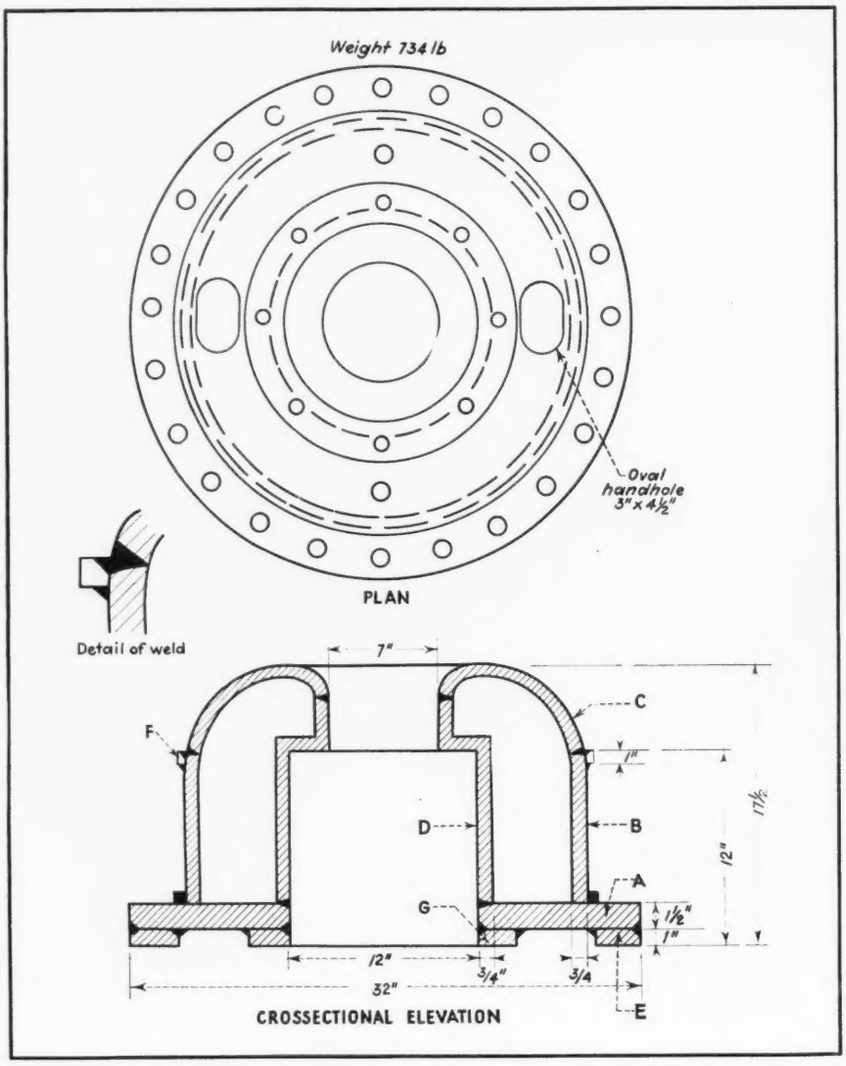
F—Seal ring of ½ x 1-in. material

G—Ring of 1 x 2-in. material, 12 in. in diameter, welded to base plate to adapt head to present packing

The various steps in assembly of these parts are outlined below. Although the job can be done without a rotary chuck or table, use of such a device greatly facilitates the welding. If proper material is available, a rotary table can be built in about 2 hours and its general usefulness in welding work will pay many times over for the time spent. The number of passes in the welds listed below depends on method used to turn the head as welding proceeds, that is, whether turning is constant or intermittent.

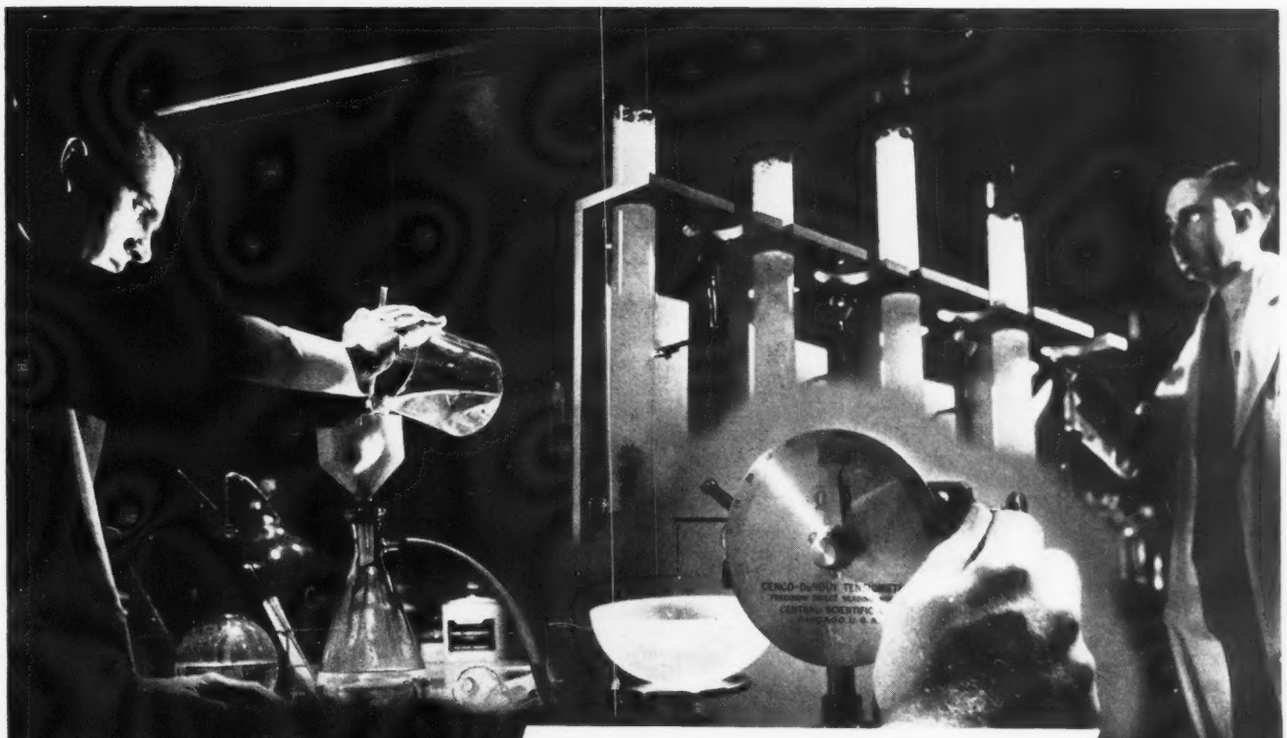
1. Weld ring (E) to base plate (A); two welds required
2. Weld swage (D) to base plate (A); one weld required
3. Weld outer wall (B) to base plate (A); one weld required. This

(*Continued on page* 122)



Plan, cross-section, and welding detail of arc-welded steel cylinder-head

* Adapted from a study submitted to the James F. Lincoln Arc Welding Foundation. In its current $200,000 Industrial Progress Program, which closes June 1, 1942, the Foundation is offering 458 awards, from $100 to $13,700, for reports of advances and improvements made by application of arc welding in design, manufacture, fabrication, construction and maintenance.



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Arc-Welded Steel Cylinder-Heads

(Continued from page 120)

should be a fillet weld at least 1¼ x ⅝ in. to form a machined seat for centering the head in the cylinder

4. Weld dome (C) to outer wall (B) and to swage (D); two welds required
5. Weld seal-ring (F) to outer wall (B); two welds required

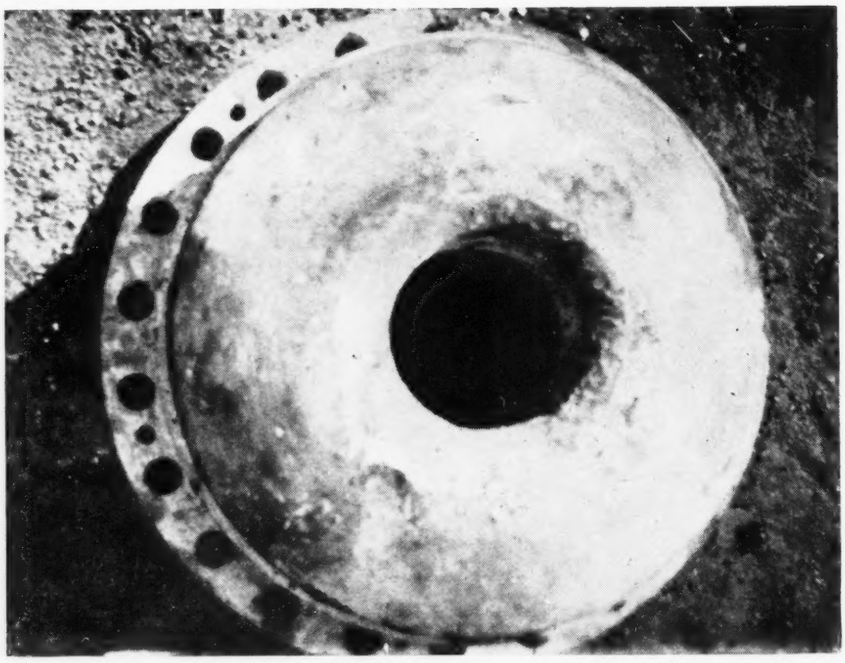
Two handholes, for cleanout purposes, are provided as shown in the working drawing. These are covered with plates, using cap screws and a gasket to hold 40 lb water pressure. If necessary at any time, operators can cut additional handholes (up to a total of four) with a cutting blowpipe. After serving their purpose, these handholes can be repaired by welding patches in place and grinding or machining to a smooth surface.

Using a proper rotary table, the steel cylinder-head described above can be constructed in 10 hr of welding time, plus about 5 hr of machining time. At $3 per hr, this gives a labor cost of $45. Incidentally, the $3 per hr for welding includes machine rental, operator's time, and welding rod. The standard plate material, amounting to about 500 lb, cost $20 at $0.04 per lb. The swage and the cap or dome, which were bought fabricated, cost $15 and $20, respectively. This all adds up to a total cost, for labor and materials of $100, which runs about half what a conventional replacement head would cost.

Chief among the advantages of replacing cast-iron heads with steel units is the elimination of cracking. At one time, so many cast-iron heads cracked in service that a company transporting natural gas on a pipe line system equipped with booster stations experienced an actual "famine." Basic cause of cracking in cast-iron heads lies in the accumulation of scale and sediment in the jackets and head, which is often difficult to prevent under field conditions. Reduced rate of heat transfer from cylinder to water causes higher metal-temperature and carbon in the iron tends to separate. The high metal-temperature likewise reduces the strength of the head. Actual cracking usually occurs when cooling water penetrates a fissure or porous spot in the scale and chills a portion of the head when the rest of the metal is overheated and weakened.

Use of rolled and forged steel, having a different structure from cast-iron, eliminates danger of cracking. Other advantages of the arc-welded steel heads include: (1) 30 to 40% more water space, because greater strength of steel permits thinner walls, (2) heads can be made easily in the plant maintenance shop equipped for welding, or in the average welding shop, (3) in this particular case, the welded steel head weighed 734 lb, a saving of 366 lb over the replaced cast-iron head, which weighed 1100 lb, (4) the welded head is unaffected by pre-ignition shocks and (5) it cost about half what a replacement head would have cost.

After welding, and before machining, annealing at 1600-1650 F to relieve stress makes the steel finer grained, and thus better for this service. The interior of the head, in the water spaces, can be metallized, or a "clad" steel can be used for these surfaces. By these means, a steel head can be used with no bad effects even where the water supply is extremely corrosive. Scale and sediment accumulations in a steel head can be removed satisfactorily by use of inhibited acid, which will not harm the steel. Sandblasting is also effective for scale removal and internal cleaning.



Finished arc-welded steel cylinder-head for 1250-hp gas engine

✦ ✦ ✦

Peepholes in Hrt Settings

► BECAUSE BULGING of shell plates forms a common source of trouble and expensive repairs in hrt and other firetube boilers, some engineers find it advisable to install peepholes in the settings, according to a recent issue of *The Locomotive*.

Many boilers are set so high above the firing doors that the external shell surfaces cannot be seen except by entering the fire box. Often stokers, small firing doors, brick-lined openings, and other obstructions prevent proper visibility. Thus shell plates of some boilers are never seen between idle periods and bulges form unnoticed. By frequent observation, engineers can detect the start of a bulge and prevent its progress to possible rupture.

The peephole may consist of a cone-shaped opening in the wall, about 12 in. below the shell, or a pyramidal hole, which is more easily built. Locate the peephole so that the observer can look down the length of the shell, preferably at a quarter view. As an alternative, several holes can be made in the longitudinal wall. In any case, the observer should be able to see the entire length of the shell exposed to direct heat. To prevent setting leakage, cement heat-resistant glass in the opening or install a standard observation port with a built-in viewing glass.

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PIPE-EATING RUST is also a profit-eater. For every time a pipe clogs or rusts through, you lay out money for repairs—and perhaps write off some down-time too.

Copper Tubes end all that because they're absolutely rustproof. Further, their installed cost in smaller sizes is scarcely more than that of rustable piping; and, with larger sizes, space savings due to compact fittings often more than save the higher material cost.

That's why so many cost-minded maintenance men regard Anaconda Copper Tubes as the piping that's the most dependable and the least costly in the long run . . . Anaconda Copper Tubes and Solder Type Fittings are sold through leading wholesale distributors everywhere. 4116

ANACONDA
from mine to consumer

Anaconda Copper Tubes

THE AMERICAN BRASS COMPANY, General Offices: WATERBURY, CONN.

In Canada: Anaconda American Brass Ltd., New Toronto, Ont. • Subsidiary of Anaconda Copper Mining Company

Power Engineers Stress National Defense

▶ With the Lord Baltimore Hotel, Baltimore, Md., as headquarters and about 1000 delegates and their friends in attendance, the National Association of Power Engineers held its 59th annual convention and 40th exhibit of power equipment, Aug. 25 to 29. Most of the meetings, and the power exhibit, were held in the 5th Regiment Armory.

Opening the convention, national president Otto L Beiswenger established its theme as national defense. He said that power engineers face the greatest emergency of their careers and declared that the battle of production which the country is now fighting will determine whether or not the United States eventually will go to war.

"At no time has greater responsibility fallen to power engineers," he went on to say, "for without power in ever increasing quantities the defense program cannot succeed."

One of the principle items of business at the convention was the report of the National Defense Committee. For the past year, this committee has been collaborating with the Federal Bureau of Investigation and the Federal Power Commission on problems affecting sabotage of power systems. For the FPC, the committee is preparing an index of power plants that have power available for emergencies.

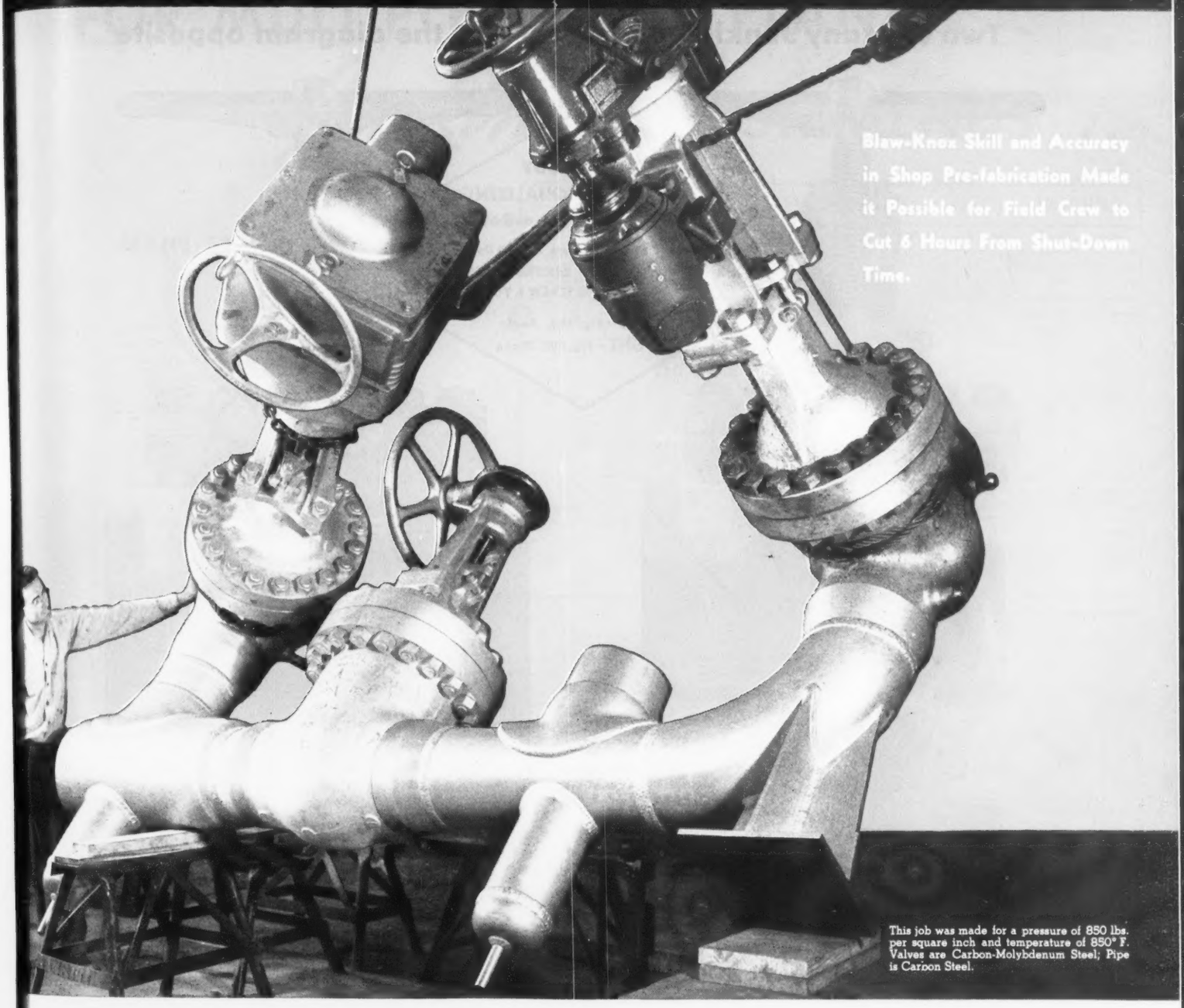
U. S. Senator William Langer, North Dakota, explained to the convention the importance of 100% organization to insure passage of a Federal License Law. This bill provides for Federal licensing of stationary power-engineers and boiler operators in power plants affecting interstate commerce or in plants designated by the Secretary of War as necessary to national defense.

A major subject of discussion at the convention was the oil crisis along the Eastern seaboard and how to conserve both coal and oil. John F. Bankley, supervising engineer, Economics Div. U. S. Bureau of Mines, spoke on the various methods of conserving coal.

Officers elected for the coming year are: Stephen C Casteel, East St. Louis, Ill. president; Clyde A. Bland, Des Moines, Iowa, vice president; Otto L Beiswenger, Akron, Ohio, past president; Fred W Raven, Room 1717, 176 W Adams St, Chicago, Ill., secretary; Harry J Harp, Philadelphia, Pa, treasurer; Evan F Dillon, Huntington, W. Va., conductor; John D Summers, Dallas, Texas, door-keeper. Convention City, 1942: New Orleans, La.

Part of the nearly 1000 members and guests who attended the 59th annual convention of the National Association of Power Engineers. Beginning at the left, in the front row, some of the officers are: national trustees, W W Downey, New York City, C A Nelson, Minneapolis, Minn. Thomas J Gambute, Detroit, Mich. and A F Thompson, Kansas City, Mo.; national president, Otto L Beiswenger, Akron, Ohio; vice-president, Stephen C Casteel, East St Louis, Ill.; past national president, C R Daubenmire, Columbus, Ohio; national secretary, Fred W Raven, Chicago, Ill., one of the grand old men of the NAPE; and national treasurer, George M Diebold, Buffalo, N. Y. Speaking of grand old men, one of them, national deputy Walter H Damon, Springfield, Mass., can be seen under the star in the upper left hand corner. He is a past national president and this year attended his 40th consecutive NAPE convention. Also in attendance at the convention but not in the picture was George B Van Tassel, who has been a member of Chicago No. 1 for 53 years and was once its president. He attended his first national convention in 1892, was the first reading clerk appointed to assist a national secretary and served as national secretary from 1899 to 1903, preceding the election of Fred W Raven to that office. In the upper right under the arrow is A Gassman, a retired power engineer from Rochester, who had the special distinction of being the only one at the convention with whiskers.

How Large Mill Saved $125,000.



This job was made for a pressure of 850 lbs. per square inch and temperature of 850° F. Valves are Carbon-Molybdenum Steel; Pipe is Carbon Steel.

Here is exemplified the money-saving, time-saving values of care and skill in designing and pre-fabricating, of experience and speed in field work.

Installation of this 9-ton assembly required the complete shut-down of the mill over July 4th. Total time allowed Blaw-Knox Power Piping Division for cutting out existing header and cutting in new header was 36 hours. The job was finished in 30 hours and the mill went back into operation one full shift ahead of time.

High-temperature, high-pressure piping calls for extreme accuracy in pre-fabrication and a sound engineering and metallurgical background.. Blaw-Knox—with its specialized skill, its unequalled facilities and resources, its highly developed procedures can save you time and money whatever the scope and nature of your piping job.

SCIENTIFIC CONTROL IN ALL PHASES OF PIPING PRE-FABRICATION

Blaw-Knox Power Piping Division has ample man-power and equipment to handle all elements entering into the design and fabrication of high pressure—high temperature piping. Where specified, control for the work includes:

Control in Bending — **Control of Grain Size**

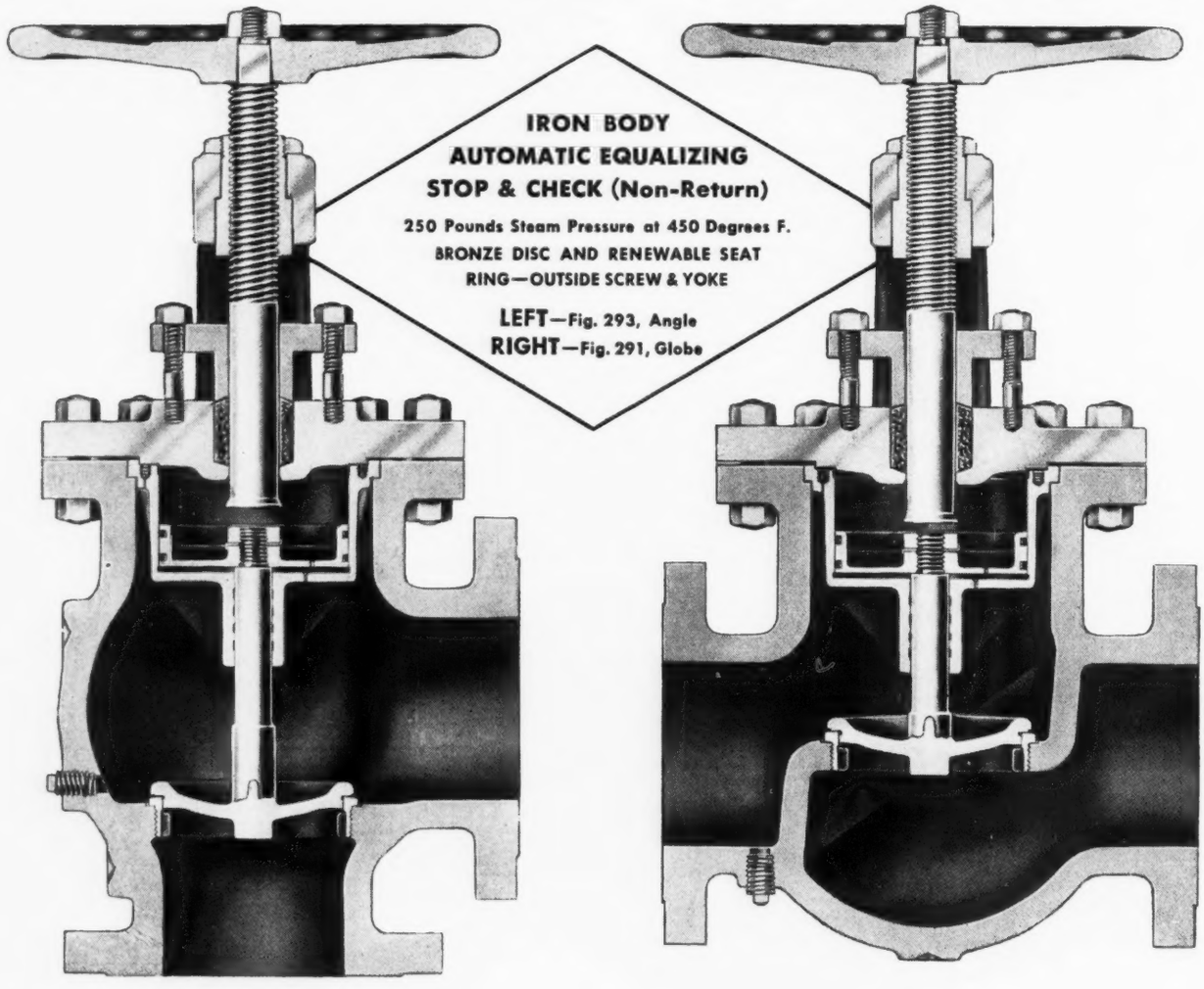
Control of Stress-Relieving — **X-Ray Inspection of Welds**

Control of Heat Maintenance During Welding

BLAW-KNOX COMPANY
POWER PIPING DIVISION
1525 Pennsylvania Ave., • Pittsburgh, Pa.

FROM GOOD VALVE DESIGN . . .

Two of many Jenkins Valves used in the diagram opposite



WHERE AND WHY this Jenkins Boiler Stop Valve is used . . .

In this type of valve the disc assembly is not affixed to the spindle. When the valve is fully opened, disc is free to rise easily on outflow of steam from boiler and return automatically to check reverse flow.

Modern practice is to install one of these valves on each boiler in a multiple-unit plant, so that if pressure in any one boiler suddenly drops below that of the others—due to a bursting tube or other form of rupture—the boiler will immediately be cut out of the line. When pressure is restored the boiler is automatically cut in again. Moreover, since the valve can be opened only by pressure within the boiler to which it is connected, steam cannot accidentally be released into a boiler which is being cleaned or repaired. The valve thus prevents injury from this cause to equipment and to men who may be working inside the boiler.

As shown in the diagram opposite, the Angle valve is generally used because it offers less resistance to flow. Installation conditions, however, sometimes require use of the Globe. Always a favorite with engineers, these Jenkins Valves have been recently redesigned to insure even smoother, more efficient operation.

Notice that the disc is of the inverted type to minimize restriction of flow. Its action is cushioned by a piston which slides in a dash pot. This piston has two hammered bronze rings which assure effective sealing, compensate wear and prevent too rapid closure and the possibility of hammer. Cast integrally with the dash pot is a husky sleeve which guides the stem of the disc and insures uniform seating. The disc has a throttling lip extending into the bore of the seat that prevents chatter under slight loads and just before closure. Note also the absence of spider construction. All obstructions to flow have been removed, reducing to a minimum the pressure drop through the valve.

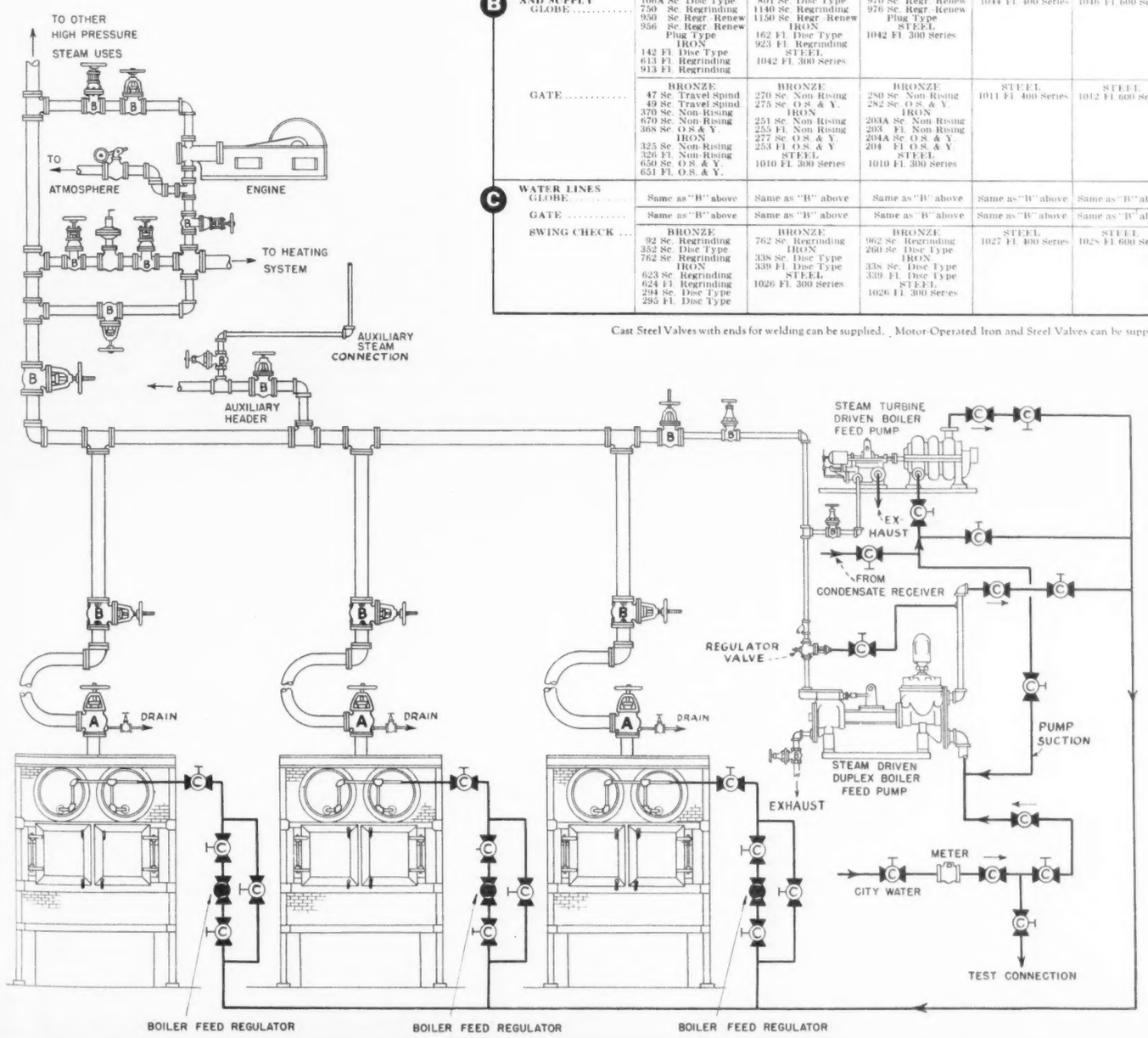
Jenkins Boiler Stop Valves are also made in Cast Steel. Figure Numbers up to Series 600 are shown in the Reference Chart.

LOOK TO Jenkins FOR THE BEST IN VALVE DESIGN

FOR MULTIPLE BOILER PLANTS . . .

Jenkins RECOMMENDS . . .

MAIN STEAM HEADERS



REFERENCE CHART FOR JENKINS FIGURE NUMBERS

		100 lbs. S.P.	Up to 200 lbs. S.P.	Up to 300 lbs. S.P.	Up to 400 lbs. S.P.	Up to 600 lbs. S.P.
A	BOILER STOP AUTOMATIC EQUALIZING STOP & CHECK NON-RETURN	IRON 293 Fl. I.B.B.M.	IRON 293 Fl. I.B.B.M. STEEL 1055 Fl. 300 Series	STEEL 1055 Fl. 300 Series	STEEL 1057 Fl. 400 Series	STEEL 1059 Fl. 600 Series
B	STEAM HEADER AND SUPPLY GLOBE	BRONZE 106A Sc. Disc Type 750 Sc. Regrinding 950 Sc. Regr.-Renew 956 Sc. Regr. Renew Plug Type IRON 142 Fl. Disc Type 613 Fl. Regrinding 913 Fl. Regrinding	BRONZE 801 Sc. Disc Type 1140 Sc. Regrinding 1150 Sc. Regr.-Renew IRON 162 Fl. Disc Type 923 Fl. Regrinding STEEL 1042 Fl. 300 Series	BRONZE 970 Sc. Regr. Renew 976 Sc. Regr.-Renew Plug Type STEEL 1042 Fl. 300 Series	STEEL 1044 Fl. 400 Series	STEEL 1046 Fl. 600 Series
	GATE	BRONZE 47 Sc. Travel Spind 49 Sc. Travel Spind 370 Sc. Non-Rising 670 Sc. Non-Rising 368 Sc. O.S.& Y. IRON 325 Sc. Non-Rising 326 Fl. Non-Rising 650 Sc. O.S. & Y. 651 Fl. O.S. & Y.	BRONZE 270 Sc. Non-Rising 275 Sc. O.S. & Y. IRON 251 Sc. Non-Rising 255 Fl. Non-Rising 277 Sc. O.S. & Y. 253 Fl. O.S. & Y. STEEL 1010 Fl. 300 Series	BRONZE 280 Sc. Non-Rising 282 Sc. O.S. & Y. IRON 203A Sc. Non-Rising 203 Fl. Non-Rising 204A Sc. O.S. & Y. 204 Fl. O.S. & Y. STEEL 1010 Fl. 300 Series	STEEL 1011 Fl. 400 Series	STEEL 1012 Fl. 600 Series
C	WATER LINES GLOBE	Same as "B" above	Same as "B" above	Same as "B" above	Same as "B" above	Same as "B" above
	GATE	Same as "B" above	Same as "B" above	Same as "B" above	Same as "B" above	Same as "B" above
	SWING CHECK	BRONZE 92 Sc. Regrinding 352 Sc. Disc Type 762 Sc. Regrinding IRON 623 Sc. Regrinding 624 Fl. Regrinding 294 Sc. Disc Type 295 Fl. Disc Type	BRONZE 762 Sc. Regrinding IRON 338 Sc. Disc Type 339 Fl. Disc Type STEEL 1026 Fl. 300 Series	BRONZE 962 Sc. Regrinding 260 Sc. Disc Type IRON 338 Sc. Disc Type 339 Fl. Disc Type STEEL 1026 Fl. 300 Series	STEEL 1027 Fl. 400 Series	STEEL 1028 Fl. 600 Series

Cast Steel Valves with ends for welding can be supplied. Motor-Operated Iron and Steel Valves can be supplied.

NEXT MONTH—CORROSIVE LIQUID SYSTEMS

 # 34
OF A SERIES
designed to help in your selection of
JENKINS VALVES

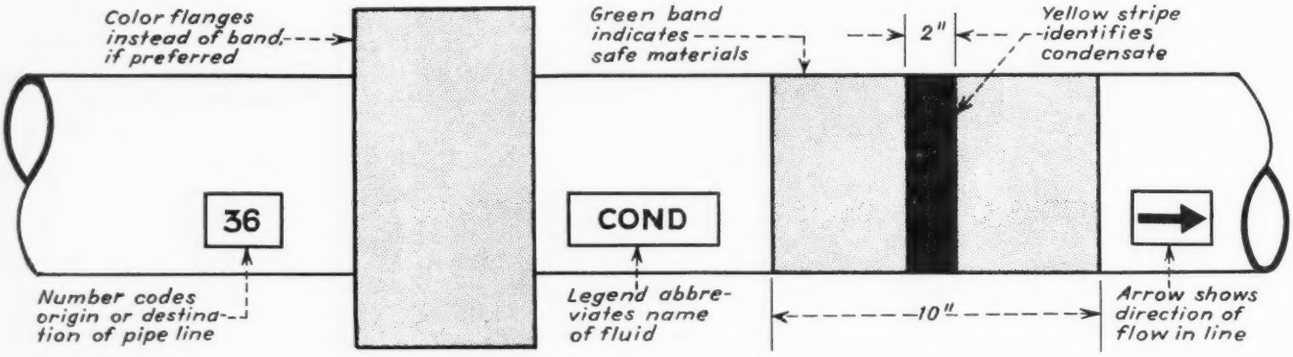
JENKINS BROS., 80 WHITE STREET, NEW YORK, N. Y.

Bridgeport • Boston • Chicago — Philadelphia • Atlanta • Houston

REG. U.S. PAT. OFF. TRADE JENKINS MARK Jenkins Bros.

Number 110

Color Code for Piping Systems


Color flanges instead of band, if preferred
Green band indicates safe materials
2"
Yellow stripe identifies condensate
36
COND
Number codes origin or destination of pipe line
Legend abbreviates name of fluid
10"
Arrow shows direction of flow in line

THE PRINCIPAL OBJECT of marking pipes with color identification is to avoid mistakes. Opening a flange in the wrong line can elect the candidate to a hospital; opening the wrong valve may wreck valuable equipment.

The secondary object is to insure quick recognition of every pipe in the plant by regular operators and to help new men in ferreting out complicated piping systems.

So the standard color code has two parts. First the entire body of the pipe, the flanges, or wide bands are painted one of five major colors to indicate safety or danger:

Dangerous materials	Yellow
Safe fluids	Green
Fire-protection	Red
Protective materials	Blue
Valuable materials	Purple

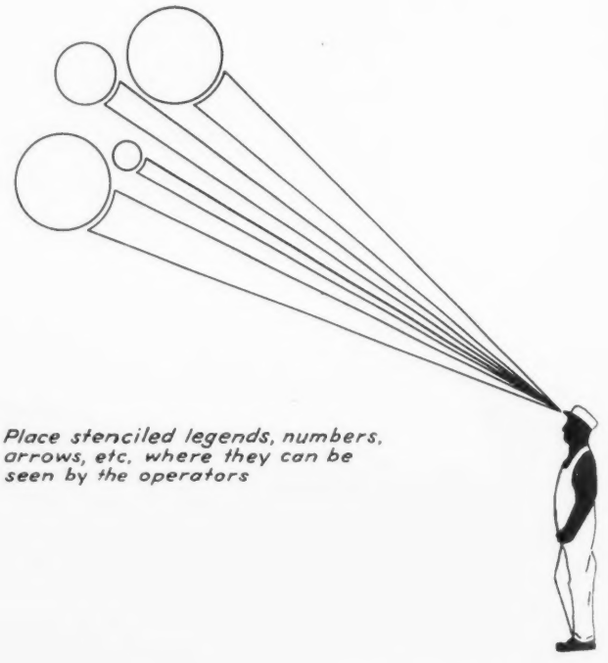
Dangerous materials include steam above atmospheric pressure, acids, chlorine, ammonia, or other dangerous gas, all fire hazards such as gasoline or oil, and very hot water. Safe fluids include circulating water, condensate, low-temperature steam, brine, and compressed air. Fire protection includes sprinkler systems, tank lines, hose stands, and foamite or carbon-dioxide systems. Classifications for protective materials, such as antidote gas for poison fumes, and valuable materials, such as lactic acid, are seldom used.

Secondary stripes or stenciled legends are a further aid in identifying the actual content of the line. For example, a 2-in. white stripe on a 10-in. orange or yellow band might indicate high-pressure steam while a black stripe could be used for low-pressure process steam. Likewise a black stripe on a green band might be used for boiler feedwater, yellow on green for condensate, blue on green for circulating water, etc.

Instead of stripes, or in addition to them, the name of the fluid, an abbreviation, or a number may be stenciled on the pipe in letters large enough to be easily read from a distance. Where direction of flow is important, stencil an arrow. Stencil in black on light background; if necessary paint a rectangular background of white or light color to take the stencil. Locate stencils on both sides of pipe, where they can be seen.

Any number of stripes are permissible in any color. Use bright contrasting colors for stripes such as buff, orange, light green, bright blue, black or aluminum. Remember stripes must go over base color indicating safety or danger.

Because most piping carries safe materials, any shade of gray, white, black or aluminum may be substituted for green, either for the body of the pipe or banding, to resist exposure to the weather or aid in classification.



Place stenciled legends, numbers, arrows, etc, where they can be seen by the operators

© POWER

PROFIT *from performance*
PROVED BY REPEAT ORDERS

If you want to get new boilers more quickly on the line . . . if you want absolutely dependable control of your boiler water level . . . specify the COPES Flowmatic. You could ask for no better proof of performance than these 34 repeat orders placed during the first eight months of this year:

User		No.	Make of Boiler	WSP Lb.	Max. Evap. Lb. Per Hr.	Flowmatic User Since	Total Flowmatics
Food Packer	2nd Flowmatic Order	1	Union	125	40,000	1940	2
Steel Company	3rd Flowmatic Order	1	Freyn	130	25,000	1937	3
Industrial Plant	2nd Flowmatic Order	2	B & W	160	60,000	1941	3
Steel Company	2nd Flowmatic Order	1	B & W	165	50,000		
	3rd Flowmatic Order	1	B & W	165	50,000	1939	3
Steel Company	2nd Flowmatic Order	2	Vogt	165	35,000	1941	3
Steel Company	4th Flowmatic Order	1	B & W	175	40,000		
	5th Flowmatic Order	2	Badenhausen	175	125,000		
	6th Flowmatic Order	1	B & W	175	40,000		
	7th Flowmatic Order	1	B & W	175	40,000	1938	10
Steel Company	2nd Flowmatic Order	1	Erie City	200	100,000		
	3rd Flowmatic Order	1	B & W	200	25,000	1940	6
Paper Mill	2nd Flowmatic Order	1	C-E	220	100,000	1941	2
Steel Company	2nd Flowmatic Order	1	F W	250	105,000	1940	2
Steel Company	2nd Flowmatic Order	2	B & W	350	300,000	1940	4
Oil Refinery	4th Flowmatic Order	1	Kellogg	390	72,000	1937	9
Navy Yard	2nd Flowmatic Order	1	Riley	405	165,000		
	3rd Flowmatic Order	2	C-E	405	150,000	1940	4
Chemical Company	3rd Flowmatic Order	1	Riley	420	300,000	1938	6
Paper Mill	2nd Flowmatic Order	1	C-E	450	110,000		
	3rd Flowmatic Order	1	B & W	450	200,000	1940	16
Synthetic Textile	4th Flowmatic Order	1	Riley	600	300,000	1938	6
Synthetic Textile	2nd Flowmatic Order	1	B & W	620	180,000	1941	2
Public Utility	2nd Flowmatic Order	2	F W	650	250,000	1940	3
Oil Refinery	3rd Flowmatic Order	1	Riley	650	125,000	1939	3
Munitions Plant	2nd Flowmatic Order	1	Riley	675	150,000	1937	3
Munitions Plant	2nd Flowmatic Order	2	Badenhausen	150	30,000		
		1	Badenhausen	700	45,000	1941	12
Munitions Plant	2nd Flowmatic Order	1	Riley	725	125,000	1937	3
Public Utility	3rd Flowmatic Order	3	B & W	865	433,000		
	4th Flowmatic Order	3	B & W	865	550,000	1940	10
Public Utility	6th Flowmatic Order	1	F W	875	550,000	1937	7
Public Utility	2nd Flowmatic Order	1	Riley	900	300,000	1940	2
Public Utility	2nd Flowmatic Order	1	B & W	900	450,000	1940	2
Public Utility	2nd Flowmatic Order	1	C-E	975	500,000	1940	8

These 26 users now have 134 COPES Flowmatic Regulators installed or on order. Name of any user will be furnished on request.

Write for descriptive Bulletin 429

NORTHERN EQUIPMENT COMPANY, 1011 GROVE DRIVE, ERIE, PA.

Feed Water Regulators, Pump Governors, Differential Valves, Liquid Level Controls, Reducing Valves and Desuperheaters

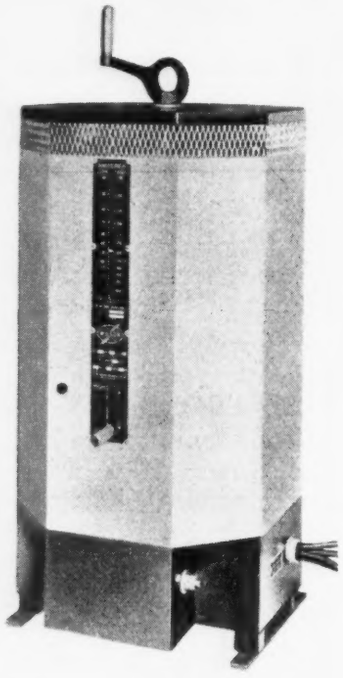
★ GET CLOSER LEVEL CONTROL WITH THE COPES FLOWMATIC ★ REGULATOR

FEEDS BOILER ACCORDING TO STEAM FLOW-AUTOMATICALLY

WHAT'S NEW IN PLANT EQUIPMENT

Arc Welders

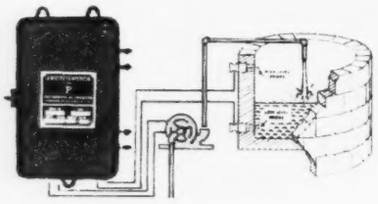
MODEL TW WELDERS are self-contained units for 220, 440 or 550 volts, 25- or 60-cycle current. Units have wide range of current output, and continuous stepless current regulation is provided over entire range by means of hand crank on top of the machine. On 60-cycle

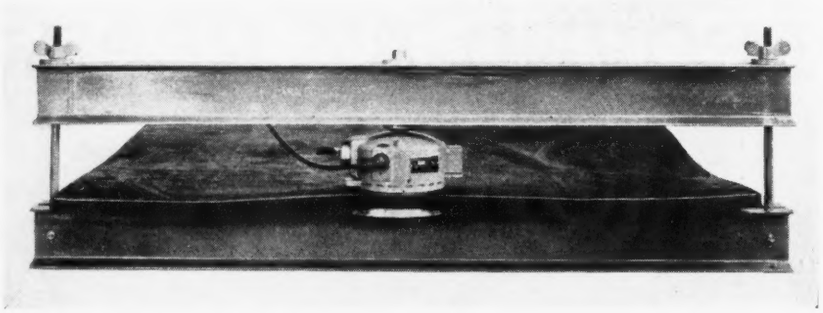


units, all sizes are fan cooled except 300-amp size, which is cooled by natural draft. On 25-cycle units all sizes are fan cooled. Power-factor-correction is included in all models for 60-cycle operation, except the 300-amp size. Welders built for 25-cycle operation do not have power-factor correction. *Wilson Welder and Metals Co, 60 E 42nd St, New York, N. Y.*

Level Control

PHOTOSWITCH LEVEL CONTROL provides on-and-off-valve control of any liquid. Probes or electrodes are attached to tank at levels representing low point where pumping starts and high level where pumping stops. Probes are wired





to level control. When liquid level falls below lower probe, control starts pump and tank fills. When level rises to upper probe fluid acts as conductor of small amount of current required for control operation, which stops the pump. Complete equipment available for single-level indication and control, on-and-off pump-up and pump-down control at two levels, boiler feedwater control and low-level safe guards. *Photoswitch Inc, 21 Chestnut St, Cambridge, Mass.*

Temperature Indicator

AUTOMATIC INDICATOR SERVES where large number of thermocouple temperature readings are to be taken. As many as 50 couples can be used with one instrument. All are individually connected to model switches on indicator front to read a couple's temperature. Operator simply throws switch and pointer moves automatically to correct scale position. Unit has no dials or galvanometers. *Leeds & Northrup Co, 4934 Stenton Ave, Philadelphia, Pa.*

Impact Wrench

AIR-OPERATED impact wrench constructed with heat-treated aluminum alloy housing. Designed with Pott impact wrench principle which localizes

steel-to-steel impact without transmitting shock to other tool parts. Tool has pistol grip with trigger-type throttle. Rotation can be reversed by lever. *Ingersoll-Rand Co., Phillipsburg, N. J.*

Vulcanizer

TYPE RO PATCH VULCANIZER is designed for repairing conveyor-belting covers. Unit is 10 in. diameter, of the single-heater platen type and clamps against a steel plate 12 in. diameter, held against opposite sides of the belt. *B F Goodrich Co, Akron, Ohio.*

Reversing Motor

CAPACITOR-START REVERSING MOTOR for cranes, hoists, and other industrial applications where instantaneous reversing is necessary. Come in ratings of from 1/6 to ¾ hp, single-phase, 60-cycle, and operates at 1725 rpm on 115- and 230-volt circuits. To reduce maintenance, no brushes or commutators are used. In operation, drum switch is closed, setting up power circuit through solenoid relay and motor windings. Relay transfers circuit from lower to

upper contact, and locks relay across the line. Line voltage across main and starting windings starts the motor. Centrifugal starting switch opens at a predetermined speed to disconnect starting windings, and motor operates on

(*Continued on page* 154)

INCREASED RATING of existing boiler installations results in a tendency to carry over entrained solids into the steam. Chemical characteristics of boiler concentrates may also be responsible for excessive and destructive foaming and priming.

For stubborn cases of foaming and priming that are not due principally to boiler design, Betz engineers make use of special formulations of Reactive Organic Colloids, developed through years of research in laboratory and field. Material savings result from the higher quality of the delivered steam, reduction in rate of blow down, and improvement in operating efficiency.

The Betz Organization is devoted exclusively to consultation, research and supervision in the field of water conditioning . . . from plant design to plant operation. In the solution of any and all water problems, Betz renders a complete service.

W. H. & L. D. BETZ

General Offices: GILLINGHAM and WORTH STS. (FRANKFORD)

PHILADELPHIA • PENNSYLVANIA

REPRESENTED IN ALL INDUSTRIAL AREAS OF U. S. A. AND CANADA

POWER LINES

AIME, ASME Program

The joint meeting of the A I M E Coal Div and A S M E Fuels Div will be held at the Hotel Easton, Easton, Pa., on October 30, 31 and November 1. Theme of the meeting will be "Better Utilization of Coal." Some parts of the program of interest to power men follow:

Symposium on Adjustment of Pulverized-Fuel Burning Equipment, prepared contributions by H Kreisinger, Combustion Engrg Co, A C Foster, Foster-Wheeler Corp, F G Ely, Babcock & Wilcox Co, and Ollison Craig, Riley Stoker Corp: Symposium on Adjustment of Underfeed Stoker-Fired Equipment, prepared contributions by George P Jackson, Combustion Engrg Co, J S Bennett, American Engrg Co, and R A Foreman, Westinghouse Electric & Mfg Co: paper on the performance of industrial chain-grate stokers, by J H Kerrick, Philadelphia & Reading Coal & Iron Co: paper on burning pulverized anthracite in steam power plants, by C H Frick, plant betterment engineer, Pennsylvania Power & Light Co: and address "Better Utilization of Coal," by E G Bailey, vice president, Babcock & Wilcox Co.

Engineers' Examiners to Meet Oct. 27-30

Representatives of 40 state boards for registration of engineers are to meet in New York, October 27-30 for the 22nd annual meeting of the National Council of State Boards of Engineers Examiners. This is expected to be one of the most important meetings of the council, as it is to be held in connection with the annual meeting of the Engineers Council for Professional Development. Participating in the discussion will be representatives of the Dominion Council of Professional Engineers of Canada, and representatives of National engineering societies of this country. Mayor F H LaGuardia of New York, will be principal speaker at the banquet.

New Diesel For Hudson, Mass., Plant

The Hudson, Mass., municipal lighting department has planned a new addition to present plant, to be completed early next spring. It will consist of a 9-cylinder Busch-Sulzer vertical diesel engine, to operate at 240 rpm, and a 2100 kw Westinghouse generator. An appropriation of about $170,000 has been made by the town for the generating unit, and about $25,000 for the station addition has been allotted. Thomas A Walsh is plant manager; Arthur L Nelson, Boston, is consulting engineer.

J E Hobson Made Tech Professor

Dr Jesse E Hobson, Westinghouse power system expert who was named America's outstanding young electrical engineer for 1940, was recently named director of the electrical engineering dept., Illinois Institute of Technology. He will teach senior and graduate students course in power system engineering and in addition will organize and direct the electrical engineering courses.

Although only 30 years of age, Dr Hobson has been in charge of application engineering on electric power equipment for Westinghouse in the northwest district. He worked with power companies on the preferred methods of designing power systems and installing equipment.

Westinghouse Men Get New Posts

D W R Morgan, George P Passmore, and A P Craig will supervise increased expansion and production activities in the Westinghouse Electric & Mfg Co's South Philadelphia Works. The plant

D W R Morgan

has at the present time about 5000 employees, turning out turbines and gears. A new $22,000,000 factory is being built

MAN'S GREATEST STRUCTURE NEARS COMPLETION

Stretching across the Columbia River for 4500 ft and built to a height of 553 ft, and with a maximum width at its base of 550 ft, Grand Coulee Dam stands today as the greatest structure every built in the history of the world. On the right-hand end of the dam can be seen one of the power plants. Two 14,000-hp service units are now in operation, one 150,000-hp main unit is about ready to go into operation, two are being installed, to go into service in a few months, and three more are on order. Eventually a second power house will be built at the left-hand end of the dam. When all units are in the two plants will have a capacity of 2,742,000 hp

HELPFUL HINTS ON CHOOSING VALVES FOR BETTER PIPING SERVICE
PLEASE CHECK AND PASS ON
While this bulletin is written primarily for the guidance of maintenance workers, its purpose and its contents may also be of interest to:
General Supt.
Supt. of Maintenance
Maintenance Foreman
Master Mechanic
Foreman Pipe Fitter
Storekeeper
POST ON SHOP BULLETIN BOARD
CRANE 150
AN AID TO DEFENSE
No. 3 of a series of bulletins designed to help industrial maintenance men keep piping systems working at peak efficiency. Issued by Crane Co.; distributed by Crane Representatives.
HOW TO KEEP YOUR PLANT GOING WITHOUT INTERRUPTION!
11 SIMPLE WAYS TO GET BETTER SERVICE FROM PIPING EQUIPMENT

Shop Bulletin No. 1 gives hints on handling valves and fittings; No. 2 shows pointers on piping placement. Ask your Crane Representative to explain how you can get valuable aid from this practical service.

Ready for you...

CRANE SHOP BULLETIN NO. 3

It's ready—to help you keep pipe lines in peak condition for peak production—to help you get maximum service from present equipment. This timely Crane Shop Bulletin Service is designed to aid you in training new maintenance men; and to caution experienced workers on piping fundamentals often overlooked with costly results. Bulletin No. 3 gives many valuable hints on the proper selection and usage of valves. Copies for distribution to your piping crews may be had from your Crane Representative—or by writing to us.

CRANE

CRANE CO., GENERAL OFFICES:
836 S. MICHIGAN AVENUE, CHICAGO

VALVES • FITTINGS • PIPE
PLUMBING • HEATING • PUMPS

NATION-WIDE SERVICE THROUGH BRANCHES AND WHOLESALERS IN ALL MARKETS

adjacent to the present company plant.

Mr Morgan will direct over-all manufacturing operation, both in the South Philadelphia Works and in the new merchant ship equipment shops. Mr Passmore takes charge of industrial

G P Passmore

relations dept. Major portion of his new duties will be concerned with securing new employees and cooperating with the manufacturing department in the plant's training course. Mr Craig will be responsible for coordinating all

A P Craig

the work of Company departments in building and equipping the merchant ship factory buildings. He has been engaged in supervising plans and construction of Navy ordnance plants being built by Westinghouse in Canton, Ohio and Louisville, Ky.

Plan Development of Hydro Reservoirs

A program for development of five giant storage reservoirs costing an estimated $19,900,000 is announced by New Hampshire Water Resources Board. These reservoirs would permit existing hydroelectric plants to boost output approximately 50%; they would be located from the Indian Stream of the Connecticut Lake Section to Stod-

(*Continued on page* 166)

POWER Promotes Sawyer and Keates; E W Feller Joins Technical Staff

Several recent changes have been made on the staff of POWER. Bayard Sawyer, formerly Associate Editor, and for several years in charge of POWER's copy and news desk, is now Promotion Manager. The bulk of his former work will be handled by Assistant Editor George Keates, who worked with Sawyer for two years as Editorial Assistant.

At the same time a new technical editor has been added to the staff.

B E Sawyer moves from Associate Editor to Promotion Manager of the business staff

Eugene W Feller, formerly Assistant Chief Operator of the Safe Harbor Plant (Conestoga, Pa.) of the Safe Harbor Water Power Corp.

Announcing the appointment of Mr Feller as Assistant Editor, Editor Philip Swain said:

"We have been actuated by our decision to broaden still further our already extensive service to the men who maintain and operate America's power plants. Mr Feller comes to POWER with 25 years of practical experience, of which the last twenty-two have been entirely in the actual operation of steam and hydro power plants. He is particularly well fitted to handle practical problems related to electricity, boilers, steam turbines, water turbines, water filtration, compressors, pumps, maintenance, etc.

A native of West Virginia, Feller left high school in 1916 to work in a tannery. Next he was setter on the log carriage in a sawmill. In 1918 and 1919 he served as machinist's helper in a railroad shop, and then went to Chicago for six months of practical electrical studies in the Coyne National Trade School.

He started his power-plant experience in 1919, firing boilers for the Keyser Electric Company at Keyser, W. Va. During his 4½ years with Keyser, he completed ICS courses in steam and electrical engineering and ended up as plant shift engineer.

In 1924 Feller was hired as "machine

E W Feller comes to POWER as Assistant Editor after 22 years of plant operation

man" in the Holtwood Plant of the Pennsylvania Water and Power Co. There he was a sort of walking inspector, making the rounds of isolated pieces of equipment — pumps, transformers, etc. Later he served as switchboard operator, maintenance man and finally as shift operator.

After six months on this last job at Holtwood, Mr Feller was transferred (in 1931) to the same duties at Safe Harbor, where he earned the title of Assistant Chief Operator in 1935. In this last position (which he held until he joined the POWER staff) he compiled operating instructions and assisted in the training of operating personnel and in safety activities, and was associated with the maintenance of all plant equipment.

Mr Feller has been a frequent contributor to POWER, his articles relating mainly to the practical aspects of plant operation and maintenance.

G A Keates, on copy desk, becomes Assistant Editor, taking over news and production

Why not use your key to this "treasure house" of information

There's too little time these days to take experimental chances with anything so important as tube alloys for condensers and heat exchangers... particularly when such a rich fund of practical knowledge exists in the files of The American Brass Company's Technical Department.

In these files and through the men who have assembled the facts, you have access to actual operating experience, to case histories, to the operating data on various alloys including all the Anaconda Alloys such as: Arsenical Admiralty, Super-Nickel, Ambrac and many others.

A note outlining your problem is the key to this information. Our engineers are always ready to cooperate.

ANACONDA
from mine to consumer

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Anaconda Condenser Tubes

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Subsidiary of Anaconda Copper Mining Company
In Canada: ANACONDA AMERICAN BRASS LTD., New Toronto, Ontario

Information Please . . .

The farmer was questioning his son, home after his first year at school. "What did you learn, Son?" he asked.

"I learned to chop a 1-in. wedge," answered the boy.

"Huh, don't take college to teach you that!" said the old man, taking a 1-in. cube and beginning to chop. About the third lick he took off the end of his finger. At which the boy took a 1-in. square stick, chopped a wedge at the end of it, then sawed it to length.

"Consarn it!" said the old man, "Maybe there is something to this college business after all!"

I'm reminded of that old story by the happenings of the past few months. Every production man I talk to is busy learning how to make shells, guns, or some other munitions item. The basic operations are just the same as they always were, but the finished product has to be enough different that some of 'em have already whacked off the end of a finger.

In general, the finger-whackers are the boys who insist they know all there is to know about their trade—who figure their experience is much better than any specialized training anybody else could get.

That's where they're wrong, as wrong as the manufacturer who says today, "Why tell anybody how to use what I make? Let 'em figure out for themselves, then they'll remember." That's sound reasoning if it's something pretty basic, not so sound if it's one of the tricks of the trade. What's more, self-training is very time-wasting—which at a time like this is as wrong as anything can be. Right now, we've all got to work together to get the defense program in high gear—and we can't do it by letting each man struggle through by himself.

What I plead for is a general passing-around of knowledge and experience. I want the old hands and the specialists to swap training, the manufacturers of products to do their dead-level best to pass on to every user, present or potential, just exactly how, when and where to use their products.

Of course, all of us aren't making shells. Many of you are supplying power to make 'em with. But there are just as many specialized problems there, too. What will you do if you can't get new refractories of the kind you've been using, or get the fuel your plant has always burned? Better be thinking about it now, because it's too late when the refractories or fuel aren't available.

POWER's September issue provided a groundwork for the whole thing. It's up to each of us from now on to build on that, to provide whatever information we've collected on how to do any power-plant job better. How have you learned to burn less coal? Or how have you cut down the amount of piping, valves or fittings you needed? How have you nursed a boiler or an engine through twice the usual operating life? They're all answers that will help somebody else—*if you remember to pass them on!*

George Edwards
Engineer

HERE'S HOW TO GET GREATER OUTPUT FROM POWER-PLANT EQUIPMENT ...AT LOWER COST

Even though your power-plant equipment is pushed far beyond its normal rating and is operating at greater capacity than ever before—here's how you may get even larger returns from every ton of fuel you burn.

Check up on your insulation!

There's a good chance that a careful investigation today may reveal unsuspected sources of wasted heat—lost efficiency—that heretofore have gone unnoticed, or unattended, yet which, when corrected, may materially increase the output of your plant.

For example: Are all the flanges and fittings in your steam lines fully insulated? Are gaskets sound and tight? A leak here may allow moisture to creep under the pipe insulation and greatly decrease its efficiency. How about boiler tops? Unless the insulation is in good condition, you are losing heat, wasting fuel. If any of your equipment is exposed to weather, make sure the weatherproofing has not loosened and left the insulation unprotected.

These are just a few of the potential sources of wasted fuel and lost efficiency that may exist in any power plant. To make sure that you catch every one, and stop the trouble before it goes too far, Johns-Manville offers you, without charge, the services of a trained, experienced insulation engineer. For full details on this helpful service, and for facts on the complete Johns-Manville line of power-plant insulations, write Johns-Manville, 22 E. 40th St., New York, N. Y.

PARTIAL LIST OF J-M INSULATIONS

For steam lines up to 600° F.
J-M 85% Magnesia Pipe Insulation

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For cold rooms, ducts and refrigerating equipment
Rock Cork Sheets

For refrigerated piping
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Anti-Sweat Pipe Insulation

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Pre-Shrunk Asbestocel Pipe Insulation

For steam lines to 700° F.
Asbesto-Sponge Felted Pipe Insulation

For superheated steam lines
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PYREX Gauge Glasses are made from tough PYREX brand Industrial Glass. They resist the corrosive action of hot water and steam. They resist the shock of sudden temperature changes. They are machine drawn to uniform accuracy that eliminates installation strains.

The next order you place for gauge glasses try PYREX glasses with the broad red line. They are stocked by all leading steam and mill supply houses.

"PYREX" is a registered trade-mark and indicates manufacture by Corning Glass Works, Corning, N. Y.

CORNING Glass Works Corning, New York

Pyrex Gauge Glasses

Pumping Pointers

(*Continued from page* 81)

mining the performance of the pump when driven by adjustable-speed drives, such as a gasoline engine or an adjustable-speed motor. The 1750- and 1150-rpm curves, Fig. 5 are the same as the 8-in. impeller-curves in Figs. 3 and 4, respectively. For example, at best efficiency and 1750 rpm in Fig. 5 the pump is good for 600 gpm at 54 ft head which is the same on Fig. 3 for the 8-in. impeller. When operating at 1150 rpm and best efficiency the pump, Fig. 5, is good for 375 gpm and 25 ft head, which corresponds to the rating in Fig. 4 for the 8-in. impeller.

Pump Discharge

From the curves Fig. 5 it can be quickly determined just how the pump must be operated to discharge a given quantity of water against a specified head. For instance, assume we wanted 400 gpm at 55-ft total dynamic head. On the curves, the 400-gpm line intersects the 55-ft head line at *A*, just above the 1600-rpm curve. Therefore, to get the required volume and head, the pump will have to operate at about 1625 rpm.

The pump efficiency falls below 78% about one point, or to 77%. Point *A* is also just below the 7.5-hp line, showing that the pump will require about 7.5 hp to drive it.

If we wanted 500 gpm and 40-ft total dynamic head, we find that these values intersect at *B* above the 1450-rpm curve or at about 1500 rpm, where the efficiency will be slightly less than 82% and the power about halfway between 5 and 7.5 hp, or 6.25 hp.

Head Data Needed

These curves should not be interpreted as meaning that when a pump is operating under a given set of conditions the pump performance can be determined at another speed, unless the head is known at the new speed. For example, at best efficiency and 1750 rpm the pump will discharge 600 gpm against 55 ft head. At 1600 rpm and best efficiency the discharge is 525 gpm and 47-ft head.

There is no assurance that if the pump is operating under the first condition and is slowed down to 1600 rpm it will be operating under conditions of best efficiency. It will, if the head in the system decreases from 55 to 47 ft.

The head may change faster or slower than this, depending upon how much

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SMALL-VALVE PERFORMANCE

Bring *all* your small valves up to the same top level of positive performance . . . outlaw the usual troubles, repairs and operating kinks on all lines up to 2 inches. Put your small-valve jobs in charge of Chapman's List 960 . . . the forged steel gate valve that has the interchangeable stem, wedge and seat rings of specially hardened stainless steel. List 960 handles pressures up to 800 lb. at 750°, and cold working pressures up to 1500 lb. Try this long-lived valve. *Submit it to comparative operating tests*, and you will see how it pays off with these . . .

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1 All threads are inside the valve.
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5 Flexible stem connection.
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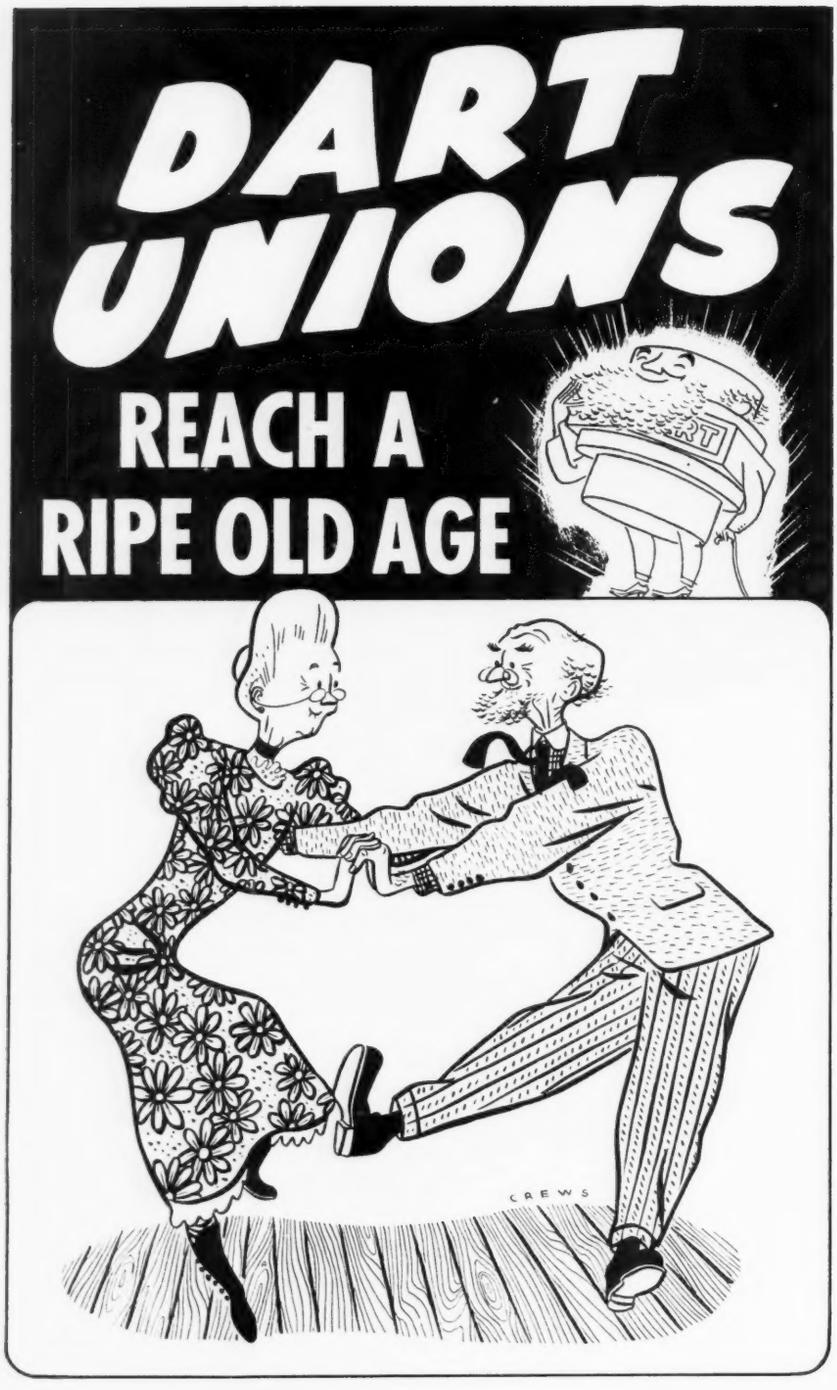

DART UNIONS still have lots of life after giving lots of service . . . they *still* make tight quickly and stay tight permanently even after having been re-installed time and again. There is no mystery about it all—Darts simply give to you, the advantages that have *been built right in to them* . . . advantages such as extra-heavy bodies and nuts, made from air refined malleable iron and matched bronze seats, ground to Dart's exclusive true-ball joints. Naturally, Dart Unions can reach a ripe old age and put up such strong resistance to pipe strains, abuse and corrosion.

Just specify size and model and we will send you a Dart Union, free.

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of the head is static and how much is due to pipe and fitting loss.

Under all conditions the static head remains constant where the pipe and fitting losses vary approximately as the square of the flow. If a considerable part of the head is pipe and fittings loss, then the head may decrease faster than shown by the best efficiency curve Fig. 5. On the other hand, if the head is largely static, then it will decrease more slowly than shown by the efficiency curve, Fig. 5. This generally will not make much difference, but if pump performance at difference speeds must be known it will be necessary to plot a head curve of the system for different rates of flow.

From the foregoing it is evident that by the use of curves like in Figs. 2 to 5 a proper pump selection can be made for any set of conditions. It is also possible to determine if the impeller of a given pump can be changed to meet a new set of conditions.

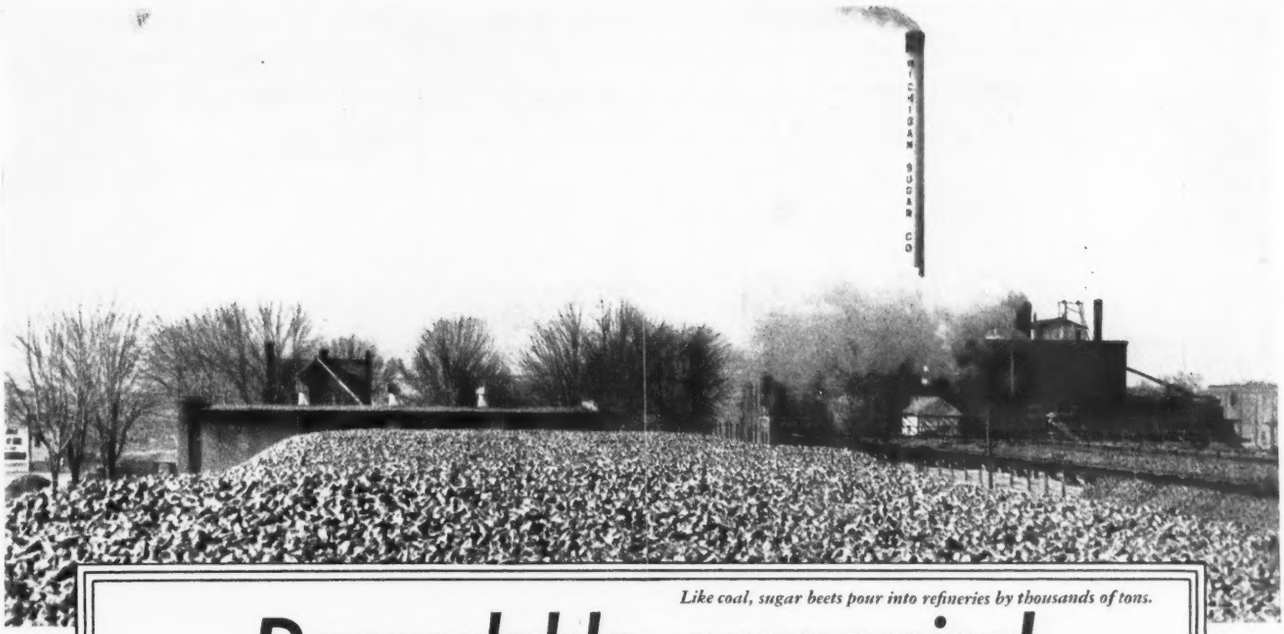
Sizes Overlap

When selecting pumps, different pump size may overlap for a given set of conditions. The problem then is to weigh the advantages and disadvantages of each pump that will meet the requirements. Assume a pump is needed to discharge 400 gpm against a total head of 48 ft at 1750 rpm. Fig. 3 shows that this 4-in. pump with a 7.25-in. impeller will do the job at an efficiency of 77% and can be driven by a 7.5-hp motor.

However, the curves Fig. 6 also show that this 3-in. pump at 1750 rpm with an 8.25-in. impeller will also do the job, but its efficiency will be only 73%. The price of this pump will be lower and it will be necessary to determine if the 4-in. pump with 4 points higher efficiency is worth the extra cost. The value of efficiency depends upon, among other things, the number of hours per year that the pump will operate under these conditions.

Difference in efficiency of two pumps is worth 4 times as much when they operate 4000 hr per year as when operating only 1000 hr. As a general statement it may be said that where operation will be fairly continuous the higher priced, higher efficiency pump will be the most economical.

Another factor that enters the picture is that the 3-in. pump will operate at maximum rating. If it is selected, its head and capacity cannot be increased at some future time if necessary, by putting in a larger impeller, as can be done in the 4-in. pump. This factor alone might make the 4-in. pump more desirable.



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Dependable, economical COAL

produces OVER 70% of POWER used by the BEET SUGAR INDUSTRY

IT TAKES a huge application of steady power to turn America's sugar-beet crop into sparkling sugar crystals. In a typical year, the job calls for 203,000 horse-power of steam to drive the prime movers in the refineries—or 125 h. p. for every thousand tons of sugar. For most of its power, the industry relies on modern, prepared *coal* . . . to make steam economically for driving its prime movers and evaporating the syrup; to boil its vacuum pans and dry the beet pulp . . . over a half ton of coal is consumed in making a ton of refined sugar.

HAVE YOU CHECKED ON POWER ECONOMIES IN YOUR PLANT?

Right now, perhaps, you're spending more than you should for power. If you want to *know* the answer, you can find out at no expense whatever. Chesapeake and Ohio's Fuel Service Engineers will be sent to your plant to make power surveys, consult with your engineers and make recommendations for attaining higher boiler efficiencies and keeping down maintenance and fuel costs. Acceptance of this service places you under no obligation of any sort. Why not take advantage of it? Simply write to GEORGE H. REINBRECHT, Coal Traffic Manager, Chesapeake and Ohio Lines, 2901 Terminal Tower, Cleveland, Ohio.

IT PAY$ TO U$E MODERN . . .

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Take Time to Test

Now is no time for electrical insulation failures that can tie up production. Wise maintenance programs regularly schedule brief "time-out" for testing the insulation of all important machines, cables and control equipment.

And of equal importance in many installations are measurements of ground connection resistances, for safety, and to avoid trouble due to lightning and other system disturbances.

Biddle Bulletins on Preventive Maintenance

- *Pocket Manual of "Megger" Practice No. 1420 P*
- *On the Use of Hand Driven "Megger" Testers, Bulletin 1655*
- *Ground Resistance Testing, Tech. Bulletin 1285*
- *"Ducter" Ohmmeter (used on Circuit Breakers) Bulletin 1635*

When writing, please mention this Advt. No charge.

The above picture is by courtesy of the Hartford Steam Boiler Inspection and Insurance Co. This and other large Insurance Companies protect their risks—and your plant—by systematic inspection and testing, in which our "Megger" Instruments play a fundamental part.

These remarkable testers, with self-contained hand-cranked generators, have served industry for more than 35 years. You make no mistake when you select them.

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"MEGGER"
TRADE MARK REGISTERED U S. PAT OFF

L H Disston Power Plant

(*Continued from page* 85)

added. Provision is made for installing induced-draft fans and collectors at that time.

The lower 50 ft of the stack, usually serving only as a support for the portion above, has in this case been constructed to form the ash tank, and to house the dustless unloader, with only the spout protruding.

The breeching also does double duty, being designed to trap flyash. Each boiler uptake enters the curved top of the breeching tangentially; each of these points acts to cause heavy objectionable material to precipitate. Hoppers at several points in the breeching connect to the pneumatic system. Collections in the stack drop through an opening to the ash tank below.

Hot-Process Softeners

Feedwater, taken direct from the Delaware River, is prepared for boiler use by a hot-process softener using phosphate, some caustic soda, and a coagulant. The usual hot-process system uses lime and soda to reduce the residual hardness below 1.5 grains per gal; then resorts to an after-treatment of phosphate to obtain zero hardness in the boiler. The water in this case averages 2.5-3 grains per gal hardness; the entire treating process is simplified by introducing phosphate direct to the softener, thus completing the treatment in the settling tank. However, provision is made for lime-soda application should hardness remain higher for any length of time and also for re-using some of the blowdown to help maintain proper balances.

Raw Water

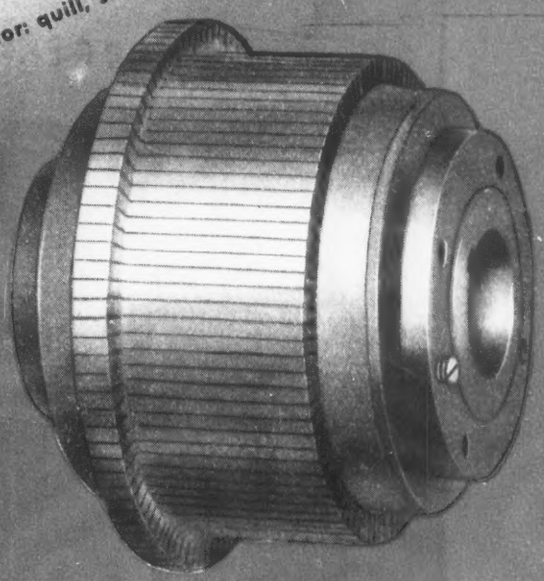
Raw water passes to a cone-bottom settling tank with a deaerating-heater top. An electric meter on the raw-water supply proportions the chemical requirements. After settling, the water flows through filters, emerging zero hard and crystal clear, and then on to the pump suction. Oily condensate from all parts of the plant collects in a receiver, from which it is pumped through a pressure filter to a separate compartment in the deaerator. It then joins the treated raw-water on the way to the pump suction. All chemical adjustments and pump controls center on a neat gage board which also carries the raw-water flow meter and feedwater temperature recorder.

A continuous blowdown system with

Typical COMMUTATOR of the NEW G-E D-C MOTOR

WE ASSEMBLE IT WITH 12 TONS PRESSURE

Assembly parts of the new G-E direct-current motor commutator: quill, steel caps, mica cones, hardened-copper and mica segments, and retaining lock nut

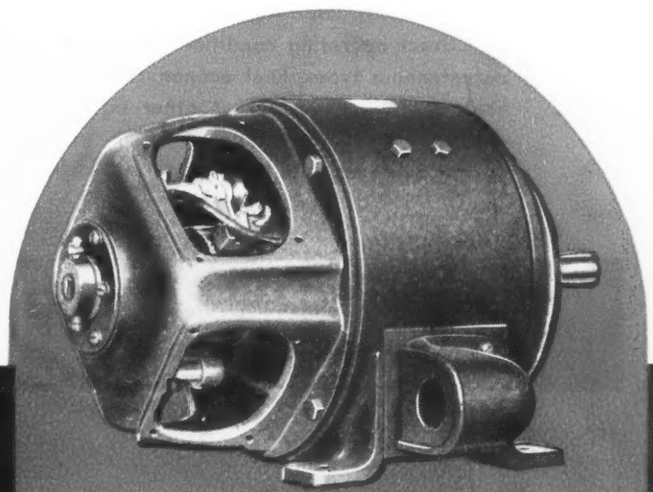


BUT YOU CAN TAKE IT APART —AND PUT IT TOGETHER— WITH A HAND WRENCH

YOU get good commutation in a G-E direct current motor because the great pressure and high temperature applied in assembling the commutator—plus careful machining — assure rigidity, uniformity, and precise alignment of every part. Yet, in an emergency, the entire commutator can be conveniently disassembled after removing a steel lock nut and set screw. Reassembling on the job requires no press.

You'll find other new features in this commutator: mica segments on the open end extend beyond the copper segments to give increased creepage paths; a tumbling process completely eliminates burrs from the hard-drawn copper segments: and the end of the assembly has a smooth, arc-resistant surface of Glyptal No. 1201 Red.

But features of the General Electric d-c motor are by no means limited to the commutator. Get the facts on the tough armature; sturdy, adjustable brush rigging; Form-ex wire field coils; and improved bearings. Call or write your local G-E office for details that show why you can expect economical, dependable service from this motor. General Electric, Schenectady, N. Y.



General Electric d-c motor, Type B, typical of the smaller ratings

GENERAL ELECTRIC

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We Build 'Em To Your Order

HORIZONTAL or VERTICAL
STORAGE or INSTANTANEOUS

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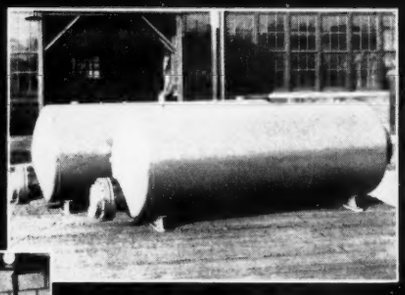
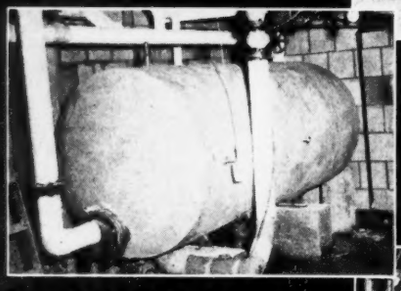
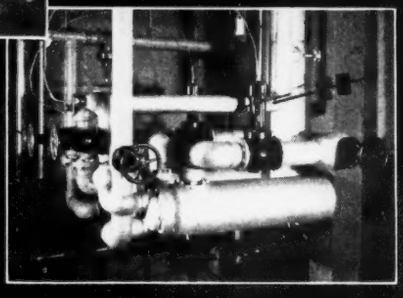
LARGE or SMALL



Two ADSCO Everdur 42 x 120 inch Storage Water Heaters built for large Canadian Industrial Organization.



ADSCO 48 x 120 inch Storage Water Heater, installed at Denison University, Granville, Ohio.



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ADSCO built-to-order heaters of simplified design are expertly constructed to rigid code standards to meet your exact operating conditions—available in storage or instantaneous types, heat economizers or special units to heat or cool water, oil or other liquids. Submit the details of your heater problem for the recommendations of ADSCO engineers or write for illustrated Bulletins No. 35-75 and 76PR.

AMERICAN DISTRICT STEAM COMPANY
NORTH TONAWANDA, N.Y.
IN BUSINESS OVER SIXTY YEARS

a single flash tank and heat reclaimer is also provided. Blowdown control valves and all sampling points for steam and water are located near the laboratory table and control gage board.

Auxiliary Drives

Auxiliary drives were selected to be adaptable to almost any plant heat balance. Two of the three forced-draft fans are driven by 2-speed motors and the third by a turbine. Air-duct interconnections permit supplying any boiler from any one or two fans.

A motor and a turbine drive the two new centrifugal boiler-feed pumps, and two existing reciprocating pumps act as spares and serve for low-load operation. These units exhaust to the feedwater heater direct, with no connection to the mill exhaust system. Steam is made up, as required, through reducing valves.

Feedwater Loop

Feedwater is delivered to the boilers through a loop, half of which serves the automatic feed regulators and the other half the hand feed connections. A separate auxiliary header supplies steam to all auxiliaries and soot blowers.

The many large and long steam mains had been the source of appreciable loss during down-time periods, because small quantities of steam had to be sent to kilns and other remote places through these large pipes. In the new system, a separate small line, supplied from duplicate connections at each boiler to an auxiliary header, is kept alive during these periods. The main header and all large mains can be closed off in the boiler house.

Feedwater heaters at each end of the old boiler rooms are retained as collectors for condensate and, under float-switch control, this is pumped to the receiver in the new boiler room.

Combustion Control

The combustion control operates normally as a metered control, responding to a differential across the gas passes. This is supplemented by CO_2 adjustment which compensates for change in coal conditions. At low ratings, however, the gas flow through the boiler does not produce sufficient differential to obtain adequate response, nor is it possible to depend on CO_2. Since smoke detectors were being provided, it was a simple matter to connect these to the CO_2 adjustment points through double-throw switches.

Fuel and air quantities respond to steam pressure and uptake draft re-

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Help Keep 'em Rolling off the Production Line!

From coast to coast and from Canada to Mexico, American industry is depending upon the quality built into all Garlock products to help maintain the high production schedules which our National Defense program requires.

THE GARLOCK PACKING COMPANY
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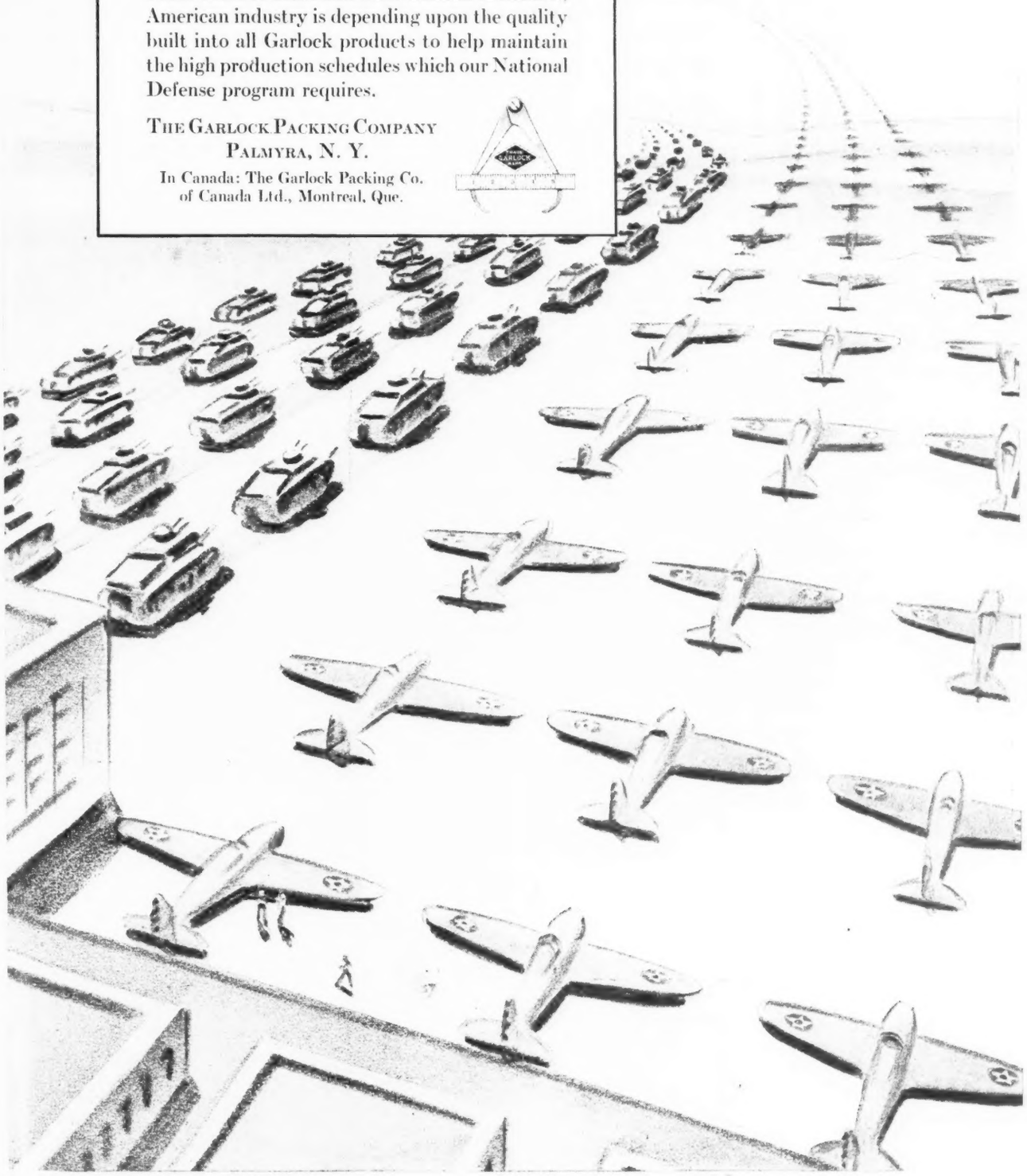

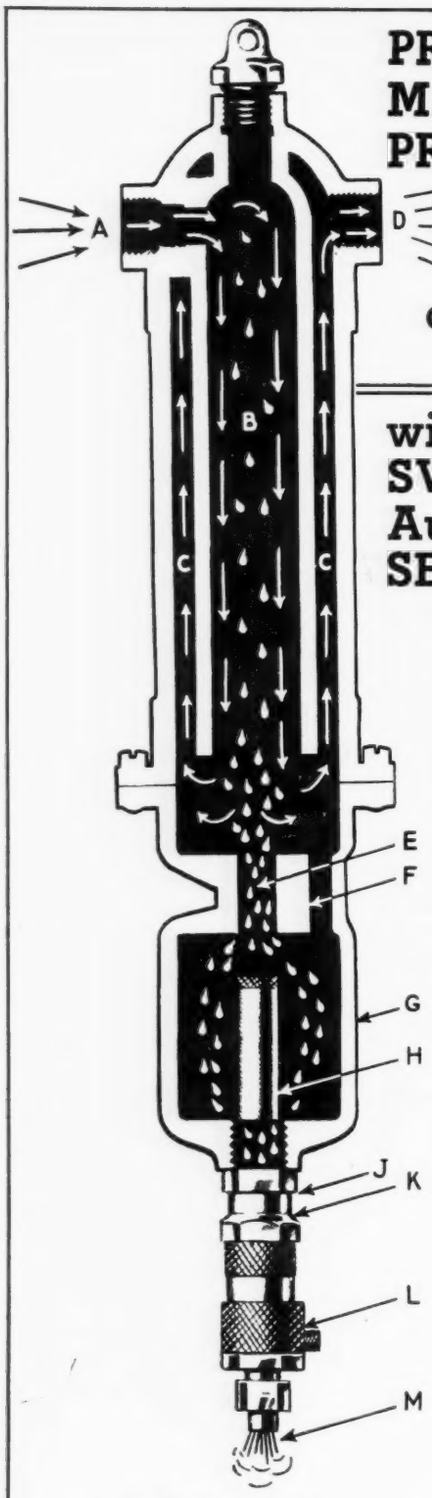

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from water— and oil-laden compressed air

with SWENDEMAN Automatic SEPARATORS

If you're using compressed air *for any purpose* — now's the time to save power and maintain high machine efficiency and keep air lines at maximum air carrying capacity — with Swendeman Automatic Oil and Water Separators.

These simple, compact, dependable units, easily connected to your present air lines, will enable you to condition your compressed air free of moisture and oil—an important problem today in every plant running at full capacity when shut downs for repairs and replacements cannot be permitted. With "Swendemans" you can safeguard your production at almost negligible cost.

SIMPLE IN OPERATION

Air enters at "A", passes into expansion chamber "B", expands and precipitates all oil and moisture into eliminator "G" from which it is immediately expelled through vent "L". The air rises through expansion chamber "C", which, having a greater area than "B", gives the air a second chance to precipitate. Clean air returns to the line at "D".

A TYPE FOR EVERY NEED

Swendeman Separators are available in a wide range of sizes and in types for installations requiring and not requiring pressure regulation as well as constant or interrupted air supply. Our engineers will gladly help you meet your individual requirements.

Ask for FREE Bulletin giving details on sizes and types

THE LEAVITT MACHINE CO.
ORANGE, MASS.

sponds to furnace pressure, insuring a negative condition in the furnace at all times. Motor-driven operators at air- and uptake-duct dampers and at the coal feeders, can be placed on automatic or hand control at the gage board, or they can be operated mechanically if the current fails.

Gage Board

The large gage board in front of the boilers carries, in addition to the combustion-control devices, all recorders and indicators needed to show every fact pertinent to correct operation of each boiler. There is a recorder for steam and feedwater pressure, multipointer draft gages reading at all essential points in air and gas passes, 6-point potentiometers giving temperature of steam, air, and gas, CO_2 recorders, boiler-water-level indicators, and smoke indicators. The board also mounts buttons and bull's eyes for the forced-draft fan, pulverizers, and future induced-draft fans.

Additional gages, meters, and thermometers and a liberal supply of test wells and connections throughout the system will facilitate testing and checking so that deviations from normal performance can be traced with little difficulty.

Design

The entire project was designed by and constructed under the direct supervision of H M Wilson Co, engineers and constructors, of Philadelphia. The various studies were developed in cooperation with Norman C Bye and Roy J Scheetz of Henry Disston & Sons, whose records of operation and costs were of inestimable value.

Compressor Lubrication

(*Continued from page* 88)

mining whether or not the feed is correct is by inspecting the compressor interior. If the surfaces are dry and show signs of rust, the feed is too meager and should be increased; if lubricant has accumulated in the ports and clearance spaces, the feed is excessive and should be reduced. If all parts show a uniform and just-visible film, the feed is correct.

Lubricants for these compressors should first and foremost have the correct viscosity and possess maximum chemical stability. The first of these, viscosity, is in no way dependent on or

WE RENEW OUR PLEDGE

Two years ago, at the beginning of the present war with its uncertainties and threats to the future of all industry, this Company publicly pledged itself not to increase its selling prices.

On this, the second anniversary, we again publicly renew that pledge.

During the last two years we have not only kept the pledge previously made, but *we have actually reduced our selling prices by more than 6%* because of more efficient operation made possible by the marvelous cooperation and ability of our organization. This was accomplished in the face of rising labor and material costs, both of which have been increased by considerable amounts.

It is our belief that the only hope for the continuance of the present industrial system now threatened from within and without is in its ability to give more and more to the consumer for less and less of his dollar. This is the strength of American individual initiative. This is the hope of our country's future. If American industry can accomplish this universally, we need not fear dictators either at home or abroad.

THE LINCOLN ELECTRIC COMPANY

Cleveland, Ohio
October 2, 1941

J. F. Lincoln
President

Golden Anderson
SPECIALTY
VALVES

STEAM PRESSURE REDUCING

To insure a uniform terminal pressure on varying capacities, employ this superior G-A Steam Pressure Reducing Valve. It is particularly adaptable for intermittent or dead end service. Furnished in sizes ranging from 2½" to 12", it is of Double Extra Heavy cast iron, with a semi-steel, or cast steel body and bonnet. Trim consists of either bronze, monel metal or stainless steel. Efficiently handles 125 lbs. to 400 lbs. of saturated or superheated steam. Pilot control may be located remotely from the main valve. For a free copy of the latest G-A catalog . . . write today . . . it contains detailed construction and application data on the complete line of Golden-Anderson Specialty Valves.

also

Altitude Control . . . Throttle and Emergency Stop . . . Check . . . and other types of valves.

GOLDEN-ANDERSON VALVE SPECIALTY CO.
FULTON BLDG. PITTSBURGH, PA.

related to chemical stability. An oil may have the correct viscosity or a grease may possess the right consistency for the unit at hand yet may be utterly unsuitable because of its lack of chemical stability. In the table are given viscosities of oils and consistencies of greases that have been found in actual practice to be suitable for these units.

Chemical stability of lubricant refers to their susceptibility to oxidation or other degradation while in service. The user, unfortunately, has no positive means of determining this property other than actual use in service, as no reliable test has been developed. In general, however, if a high-grade, well-filtered, neutral, pure mineral oil of the right viscosity is obtained from a reputable refiner, the likelihood of having lubricating troubles is remote.

Reader's Problems

(*Continued from page* 111)

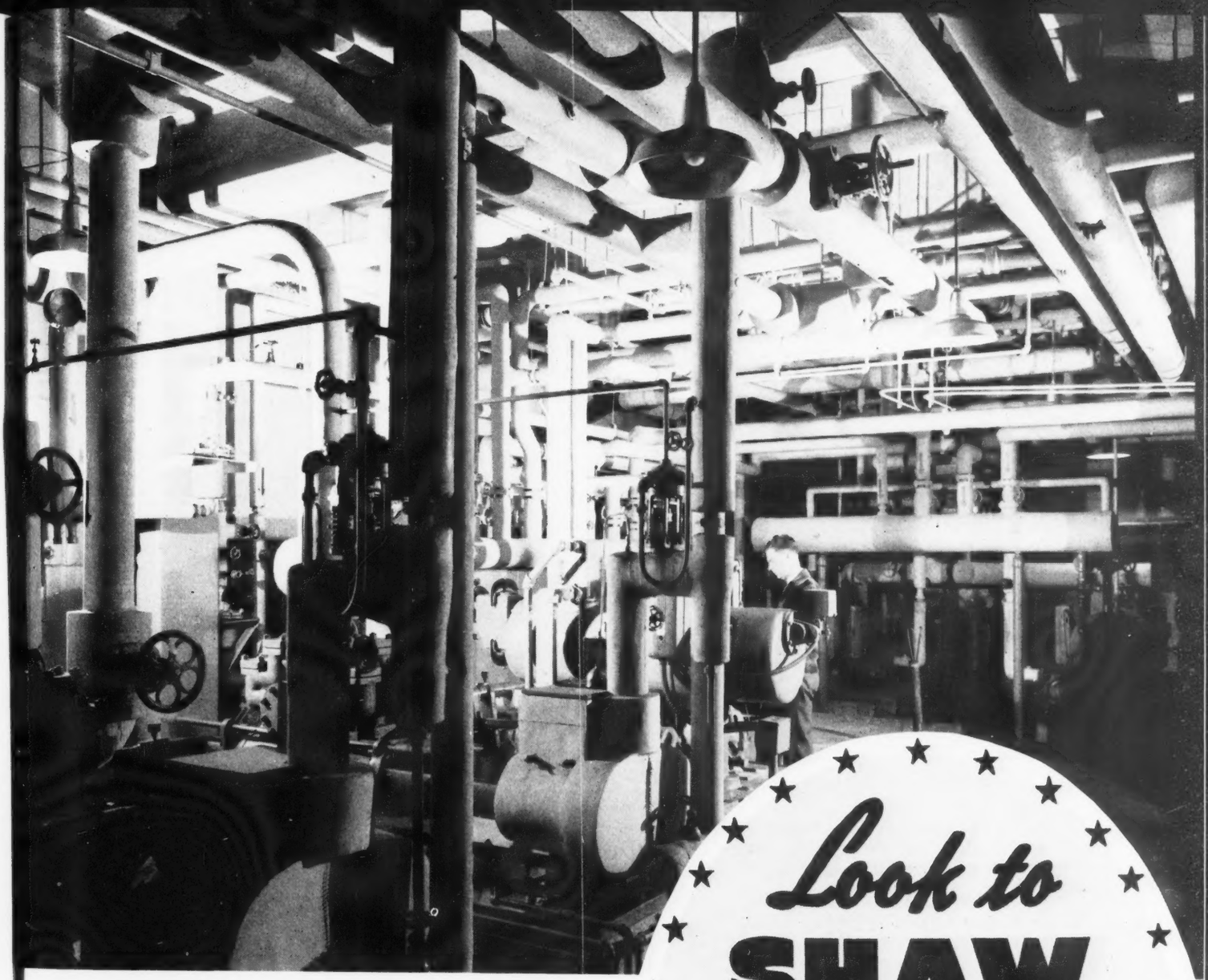
to remove them from the system.

It is sometimes advantageous to note the reading of the high pressure gage when the machine is stopped and the water is flowing over the condenser at full force. These pressures are shown by the following table when the non-condensable gases are present in small quantities only:

Temp of Air & Water Over Condenser, F	Condenser Pressure, Lb per Sq In.
50	74
60	93
70	115
80	139
90	169
100	199

The foregoing table shows the pressures which correspond to the saturated temperatures when the ammonia is pure. It is evident that any non-condensable gas will increase the total pressure in proportion to the partial pressure of the non-condensable gas. Thus if the pressures registered by the high-pressure gage are considerably higher than those shown by the table, it is an indication of the presence of non-condensable gases and that the condenser should be purged.

The purging that is required varies considerably with the type and size of plant. In some plants it may be necessary to purge the condenser weekly, while others would need to be purged only every month or so. It is apparent that an excessive amount of purging causes a waste of ammonia and should be resorted to only when the pressures demand it. In order to remove the non-condensable gases the coils should be allowed to become as nearly full as possible with liquid and then should be cut out of



DELAWARE HOSPITAL

WILMINGTON DELAWARE

Evidence of the Merit of Shaw Ability is the varied and complete work (prefabrication and installation) done on the new outstanding Delaware Hospital Building, Wilmington, Delaware, recently completed. The many varied projects include: 1. The complete boiler plant, including boilers, oil burners, and auxiliary boiler equipment, instruments, etc. 2. The complete heating and ventilating equipment. 3. All high pressure steam piping to Laundry, etc. 4. All medium pressure steam piping to Kitchen, Sterilizer equipment, etc. 5. All Air Conditioning. 6. Incinerator. 7. Pneumatic Conveyor System.

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BENJ. F. SHAW COMPANY

2nd & Lombard Streets, Wilmington, Delaware

PIPING FABRICATORS AND CONTRACTORS

Fig. 0251
250 lbs. steam pressure

Instead of the usual wedge or disc, Fairbanks Sphero has a revolving ball plug which wipes the seating surface clean. Its shearing action cuts through heavy solids and liquids. There is nothing on which foreign matter can accumulate.

The opening in the ball plug is the same size as that in the pipe. There are no obstructions, no frictional resistance. It's clear sailing for steam, oil, water, etc.

Wear on seat rings is reduced to a minimum by the rotary motion of the ball. And seat rings can be kept permanently tight by adjusting the wedge at bottom.

It can be opened or closed as "quick as a wink" by the long lever handle. A positive stop tells when fully open or closed.

Seat rings or other parts which may become worn, can be replaced without removing valve from the line.

Try just one Fairbanks Sphero Valve for blow-off purposes and services where a full flow, quick-acting valve is desired and you'll wish you had used them before.

Send for Catalog No. 21 and name of our nearest distributor.

THE FAIRBANKS COMPANY
Valves, Dart Unions, Hand Trucks and Wheelbarrows
397 Lafayette St., New York, N. Y.

Boston, Mass., Pittsburgh, Pa.
Factories: Binghamton, N. Y., Rome, Ga.

Fairbanks Sphero Valves

service by the manipulation of the proper valves.

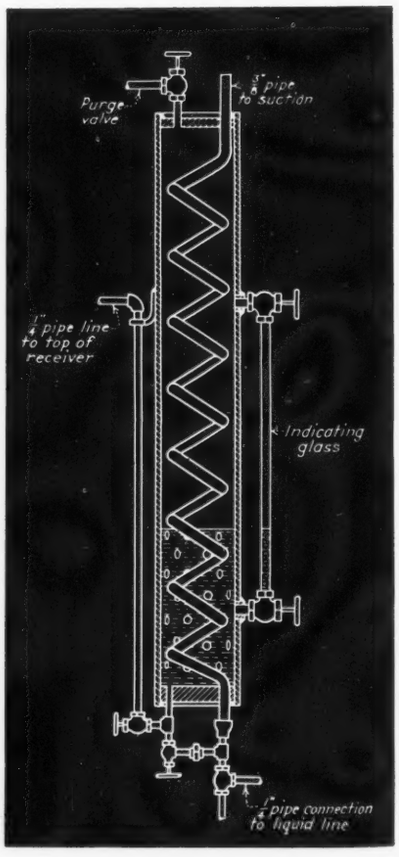
Condensing water should be allowed to flow for two to five hours over the sections to be purged to allow the ammonia to condense and the gases to separate from the liquid ammonia as much as possible.

The purge valve on each section or at the top of the condenser should be connected to a pail or barrel of water if it is desirable to eliminate the disagreeable odor of ammonia. The purge valve should then be opened only slightly; as long as the permanent gases are passing into the water it will simply bubble. But as soon as ammonia comes into the water the familiar cracking sound is produced which is similar to the sound of steam being introduced into water and the purge valve should be closed immediately. After an interval of a few minutes, the process should be repeated. Usually a few purgings in this manner will remove all of the non-condensable gases from the condenser.

Atlanta, Ga. J. L. SANDERS

Suggests Purger Design

NO SATISFACTORY PURGING of foul air can be accomplished with JAC's method "when the compressor is running." I submit a sketch of a separator which I have used successfully in ammonia refrigerating plants of every description. The cylindrical portion of the separator is open to condensing pressure by means of a ¾-in. pipe connected to the top of the ammonia receiver. Liquid ammonia is expanded through a spiral expansion coil, which reduces or subcools the liquid carried in the separator to a point



Dan Griffin Speaks for Steel...

★ Below are quoted the remarks of Dan F. Griffin, a steel worker in the Campbell Works of The Youngstown Sheet and Tube Company, made recently at a meeting of a Youngstown, Ohio, civic club. Reflecting the attitude of Youngstown employees, his words should be of interest to the users of Youngstown steel.

"Today, the eyes of the world are turned upon the ever-increasing conflagration in Europe. We realize that our nation has undertaken the gigantic task of transforming a peace-time nation into a nation geared to total national defense.

"The steel mill employee is playing an ever-increasing and more important role in this task; and the American steel man is tops in the industry.

"We know that as much depends upon the skill and devotion of these steel mill employees as on our armed forces on land, sea, and in the air. To a man, the steel mill employees of America appreciate they are among the highest paid workers in the world. Their working conditions are the best.

"The American steel worker has plenty of leisure time to do as he will. He can work in his garden; he can seek any form of entertainment, not only for himself but also for his family. He can study to improve himself, and quite frequently does. He is in no way limited.

"The highest office in our land has been occupied by men of the most humble birth. Freedom in America has never had a price, but its rewards are unlimited. Your steel mill employee knows that he cannot buy freedom—he must think freedom—he must work for freedom.

"We treasure our American way of life as we have it today. We're prepared to go to any lengths to preserve for ourselves and for our children that tranquility, that comfort, that peace, which we have enjoyed in years past.

"We're willing to pay our share in money or labor—yes, we are already lending. We want our boys to serve—they're already being trained for service.

"Our steel workers' creed should be an all-out effort to procure peace for ourselves and for the rest of the world. If we must work harder or longer to produce the steel necessary to insure that peace, then we're ready and anxious to do our bit, for in that way only do we serve.

"The Army needs steel—we'll make it.

"The Navy needs steel—we'll make it.

"The Air Force needs steel—we'll make it.

"The whole world needs steel, and steel workers will make it, for the real steel man is a true American. He will never do or think anything to jeopardize America. He will do everything in his power to preserve America for Americans and Americanism.

"We'll remember, always, that the men of the Army, the men of the Navy, the men of the Air Force, those defending democracy and the men of production are all ONE.

"We're 'Sammies' on guard!

"The U.S. in United States means US."

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SOCKET-END WELDOLETS
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The Finest that Money Can Buy
BONNEY TOOLS

ranging between 50 and 75 F below the boiling point corresponding to the condensing pressure. A combination of ammonia gas and non-condensable gas will pass into and up through the cold body of liquid in the separator. By passing these gases into the subcooled liquid, the condensable or pure ammonia gas, that would otherwise be lost, is condensed or liquified and returned to the system. The non-condensable gases thus separated rise above the surface of the liquid and are continuously discharged until every ounce of these objectionable substances are removed from the system.

Schenectady, N. Y. CARL BACHMANN

Some Other Methods

THERE ARE A NUMBER OF WAYS to purge an ammonia system, but the right and only way to do it is by installing an automatic purging machine, which insures maximum efficiency. However, few plants have such a machine and other methods have to be resorted to, such as JAC's, which is definitely not the best.

First, the purging should not be done from an oil trap, as traps have some oil in them at all times, and this oil will contain ammonia gas. The cracking sound that JAC hears is ammonia mixing with water. Second, by using so much water, JAC forces himself to open the purging valve wider to get results, with further waste of ammonia. Only 3 gal of water is necessary; with such a small amount the purge valve need only be cracked.

JAC can get better results by making a purge chamber out of a piece of 4- or 6-in. pipe about 6 ft long. Stand this pipe vertical, about 4 ft above the trap and pipe a $\frac{3}{4}$-in. line to the bottom of the chamber (see sketch No. 1, page 110). Connect the hose to a $\frac{3}{8}$-in. or $\frac{1}{2}$-in. outlet valve at the top of the chamber and run it to a pail. This will be the high point on the discharge system. The ammonia gas will condense and flow back into the discharge and the foul gas will remain at the top to be bled out later. These recommendations are based on the understanding that JAC has to do his purging from the oil trap. The proper point, in all cases, is the highest point of the condensers. No purging should be done until the machine is shut down and the water running over the condensers.

Brooklyn, N. Y. J P CAREY

New Plant Equipment

(*Continued from page* 130)

main windings as ordinary single-phase induction motor. To reverse motor it is simply necessary to throw drum switch to other side and similar sequence of operations takes place. *Westinghouse Elec & Mfg Co, East Pittsburgh, Pa.*

(*Continued on page* 156)

We'd like to say "YES!"

When a friend needs your help—needs it urgently—you like to say "YES!"

But sometimes, for unavoidable reasons, you are forced to say "NO!"

How you hate to say it!

That's the way we feel today.

Here we are, turning out millions of tons of steel — more than ever before in Republic's history.

Yet, to many of our friends—our customers who have learned to depend upon us for steel—we may have to say "NO" when we'd like to say "YES."

The reason is well known. World affairs demand that we build for defense—defense for your business, your possessions, your home, your family. And modern equipment for defense requires steel—quickly and in unprecedented quantities.

Republic must—*AND WILL*—supply first the steel needed for defense purposes.

At the same time, we want to be fair to *ALL* our other customers in apportioning steel available for non-defense use.

If we have said "NO" to you — or if we must in the future — just remember that we don't want to say it — we'd like to say "YES."

And remember, too, that the steel you can't get is the steel that is being used to protect all of us against an uncertain future.

REPUBLIC STEEL CORPORATION

General Offices: Cleveland, Ohio

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Culvert Division
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FOR WATER

Now that defense production is taxing plant capacities to the utmost, it's wise to take extra precautions against costly power leaks. Choose Belmont Packings for extra stamina and long-run economy.

Here are practical reasons why Belmont 319 Hollow Center Packing and Belmont 9 Special Hydraulic Packing will properly seal stuffing boxes of heavy hydraulic units such as presses, accumulators, draw-benches, squeezers and pressure pumps:

Belmont 319—(rubber and duck). The hollow center provides a point of least resistance for expansion and contraction. Hence, the packing will "breathe" toward the "hole" as varying conditions of service within the stuffing box are exerted upon it.

Belmont 9—(line flax stitched with a rubber-duck channel). This packing combines two distinctive materials made into one integral packing. The rubber-duck channel not only acts as a wiper, but as a protection to the flax. . . . These two packings used in alternate rings make an ideal combination set.

Send for Belmont Catalog No. 40 which illustrates and describes the Belmont Packing line for all services. A request on your company letterhead will receive prompt attention. Any authorized Belmont distributor will gladly show you samples and help you with your particular requirements.

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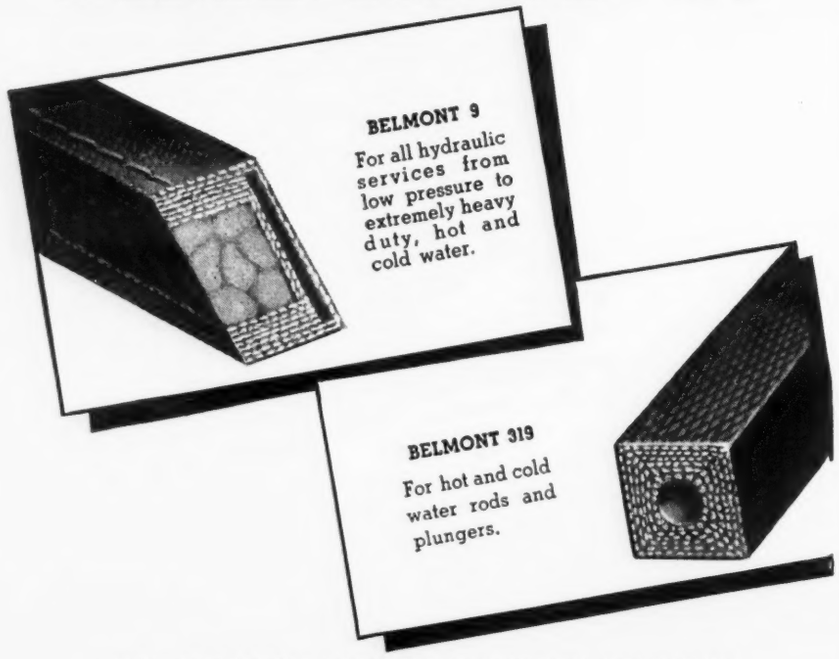
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For all hydraulic services from low pressure to extremely heavy duty, hot and cold water.
BELMONT 319
For hot and cold water rods and plungers.

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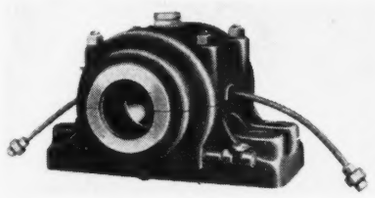
BUTLER AND SEPVIVA STREETS • PHILADELPHIA, PA.

Pillow Blocks

SLEEVOIL PRECISION pillow blocks in plain and water-cooled types designed for industrial applications, including fans, blowers, etc. Lubrication is provided by "T" section brass oiling rings. Oil gage provided which can be placed in either side of bearing, and by use of additional pipe can be extended to any distance on the bearing. Bearings are



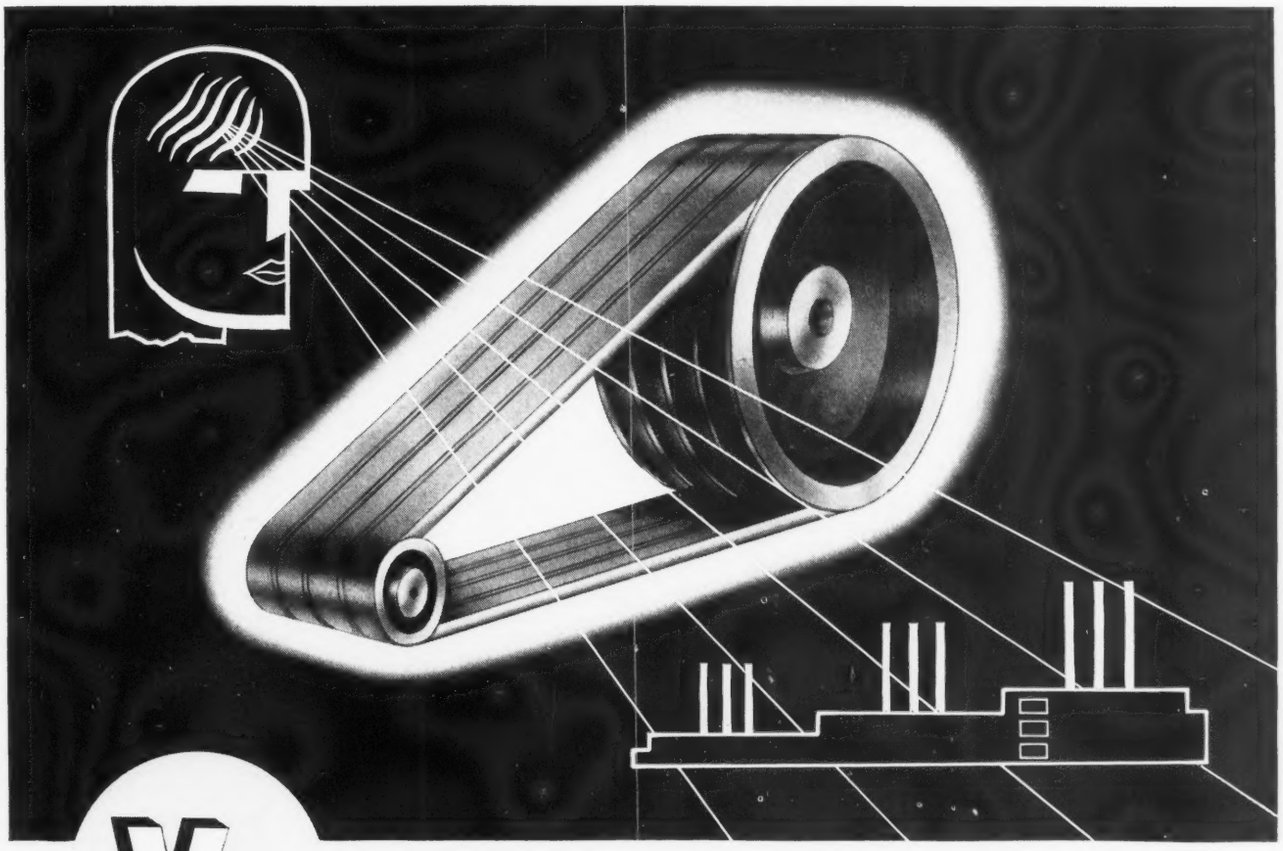
self-aligning and can be furnished in either expansion or non-expansion types. These units are identical in design and construction with plain type, except for water-cooled feature. Sizes up to and including $3\frac{15}{16}$-in. are water cooled in lower liner only, and have one flexible inlet and one outlet connection. Sizes $4\frac{7}{16}$-in. and larger are water cooled in both upper and lower liners, and have 2 flexible inlet and outlet connections. *Dodge Manufacturing Corp, Mishawaka, Ind.*

Electrode Selector

SLIDE-RULE-TYPE SELECTOR reads directly length of arc-welded joints obtainable per 100 lb of electrode, also pounds of weld metal deposited per 100 lb of electrode. Provides selector chart which shows various filler metal classifications as specified by American Welding Society, and types of electrodes which meet these classifications. *General Electric Co, Schenectady, N. Y.*

Piloted Coupling

STEELFLEX COUPLING eliminates necessity for outboard bearing on extended shafts, auxiliary bearings on intermediate shafts, and allows greater flexibility in locating driving and driven units. Units, constructed entirely of steel, consist of two hubs, one of which carries an integral flange to which cover is secured, special tempered-steel member forming complete cylindrical grid member, and flanged steel cover secured to hub flange with cap screws. Made in three types: Type P, single piloted; Type P, double piloted horizontal; Type P, double piloted vertical. Coupling is adaptable for use on steel-mill auxiliary drives, on main rolling-



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A SOLUTION for any pressure regulation problem can be found in the complete Davis Line. No matter what the pressures involved, the degree of sensitivity needed, the load requirements, or the type of service wanted, there is a Davis Regulator to fit *your* specifications.

GIVING YOU WHAT YOU NEED IS OUR SPECIALTY! In addition to the complete line of standard units, special units to meet unusual requirements are being built regularly in the Davis plant. Write today for recommendations—no obligation. Catalog on request. DAVIS REGULATOR CO., 2540 S. Washtenaw Ave., Chicago, Ill.

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REGULATOR No.	2*	8	13	14*	15	16*	18*	19*	26*	27*	40	49*	401*	17	21	48	9	29
MAXIMUM INITIAL PRESSURE	600	1500	400	400	250	400	250	250	125	125	400	1500	1500	250	125	400	250	250
MINIMUM REDUCED PRESSURE	1	0	½	0	0	0	1	1	1	1	1	0	1	0	½	10	½	¾
MAXIMUM REDUCED PRESSURE	125	300	100	200	30	125	1	1	1	15	300	100	500	100	60	200	100	100
FOR DEAD END SERVICE			✔				✔	✔	✔		✔	✔		✔	✔	✔		
DIAPHRAGM ACTUATED—Direct Acting			✔	✔	✔	✔	✔	✔	✔	✔					✔		✔	✔
PISTON ACTUATED—Direct Acting	✔																	
AUXILIARY PILOT CONTROL		✔									✔	✔	✔	✔		✔		
SPRING LOADED			✔	✔				✔	✔	✔	✔	✔			✔	✔		
WEIGHT LOADED	✔	✔			✔	✔	✔							✔			✔	✔
SERVICE: GENERAL SERVICE	✔	✔		✔	✔	✔					✔		✔	✔	✔	✔	✔	✔
SERVICE: LOW PRESSURES—Heating	✔		✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔					
SERVICE: HEAVY LOAD DEMANDS		✔			✔	✔				✔	✔	✔	✔			✔	✔	✔
SERVICE: SPECIAL SERVICE		✔	✔	✔	✔	✔	✔	✔	✔	✔		✔	✔	✔				
RANGE OF SIZES	½ to 14	4 to 24	½ to 2	½ to 12	½ to 14	½ to 14	½ to 14	½ to 14	½ to 2	½ to 2	½ to 10	½ to 14	½ to 14	2 to 6	½ to 2	2 to 14	½ to 14	½ to 14

ABOVE—A table of the various sizes and types of Davis Pressure Regulators available as standard stock items. Send for your copy of the complete Davis Regulator Service Chart now!

LEFT—No. 15 Davis Pressure Regulator for steam, gas, air, water or oil. Balanced counterweighted diaphragm gives accurate, sensitive control—unaffected by supply pressure variation.

LEFT—No. 13 Davis Pressure Regulator for small steam, air, or gas-operated equipment. Quality construction and accurate control at a reasonable price.

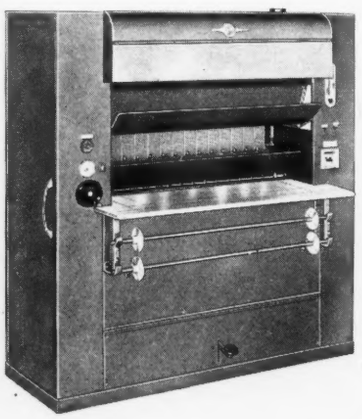
WRITE FOR BULLETIN 100A

DAVIS REGULATOR COMPANY

mill drives, horizontal and vertical pumps, and exhaust draft fans. *Falk Corp, Milwaukee, Wis.*

Whiteprint Machine

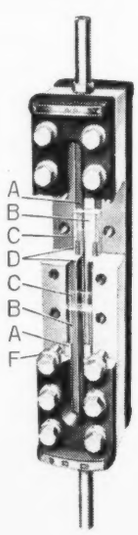
MODEL C MACHINE accommodates materials up to 42 in. wide. Blower removes hot air from printing cylinder, cools burner, and creates vacuum neces-



sary for automatic separating device. Adjustable burner-shade allows operator to vary light intensity in running long tracings of varying opacity without changing printing screen. *Ozalid Products Div, General Aniline & Film Corp, Johnson City, N. Y.*

Water-Level Gage

PRESSURE-SEALED, flat-glass insert for water-level gages are built for pressures up to 1500 lb. Features of improved design are pressure-sealed gaskets on inside faces of glasses and spring-loaded cap screws holding down front and back cover plates. Referring to illustration, cushion gaskets *A* are used on outer faces of glasses *B*. Thin sheets



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from Your Present Facilities

In This National Emergency
There Is NO TRUCE WITH TIME!

You want to increase plant capacity right now and at minimum cost—

without disturbance to continuing heavy plant output and without sinking large capital in expanded building and equipment which will become a white elephant when the emergency is past.

Then look to **Marley "Double-Flow,"** the cooling tower that adds more KW per dollar of cost than any other large-capacity type — and costs far less to operate, too. Here is a truly superior design, the latest fully-proved advancement in water cooling engineering. Result: a tower that's *ahead* structurally, mechanically, in efficiency and on all points of economy.

All the evidence is at your disposal. Write for it today — and end limitations imposed by your present spray pond, river water, wells or any other arrangement which may be preventing you from obtaining utmost capacity from your existing plant. For now, with new turbine deliveries in the far, far future you *must* get the best from what you have.

MAY WE SHOW YOU THE RECORDS OF THESE MARLEY "DOUBLE-FLOWS"?

Numerous cases can be cited where plant managements have bettered output remarkably by the simple, low-cost expedient of replacing obsolete or inadequate water cooling equipment with a Marley "Double-Flow." By enabling the plants to carry heavier loads and maintain better vacuum, these investments are paying handsome returns.

Marley Bulletin 602 tells the complete story of patented "Double-Flow" towers, an exclusive Marley development. Text is brief and factual, augmented by comparative graphs and diagrams, illustrated with a profusion of photographs showing actual installations and applications — a significant piece of engineering literature. A copy is yours immediately upon request under your firm's letterhead.

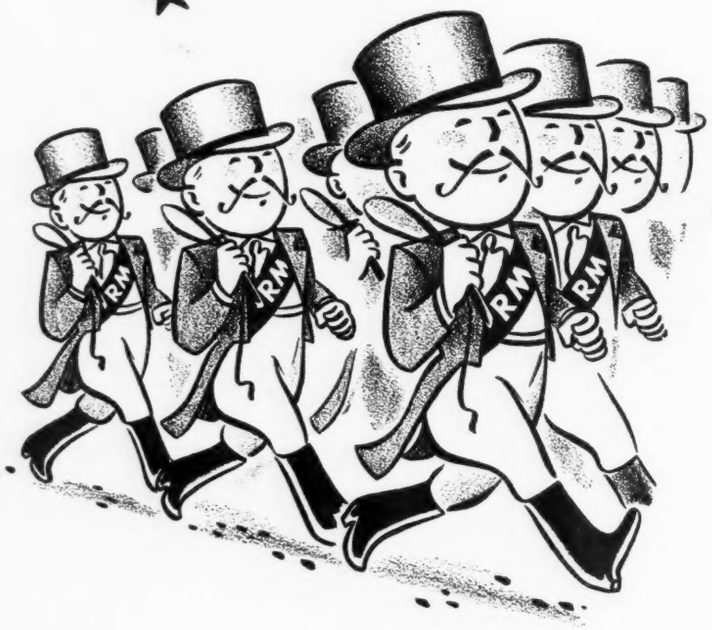
THE MARLEY COMPANY
Fairfax and Marley Roads
Kansas City • Kansas

MARLEY COOLING TOWERS

are saving money and promoting efficiency in all kinds and sizes of plants throughout industry

★ R/M PACKINGS ★
MOBILIZED FOR DEFENSE!

★

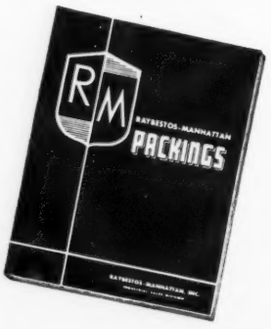


Factories are going great guns; labor and machinery are straining to keep production up to capacity. And right in step with this effort is the work of Raybestos-Manhattan packings.

Wherever water or steam must be mastered, gas or oil kept under control, corrosive chemicals confined—you'll find R/M packings doing a real job.

40 years of specializing have prepared the R/M line to handle any situation. The shortest *complete* line available, it offers *one* RIGHT packing for every job. Tough enough to stand the gaff, R/M packings mean less frequent repacking, take added strain best, and require least attention.

If speed and safety and increased output count in your plant enlist the aid of your R/M distributor. He's ready to put R/M packings at work for you—now!



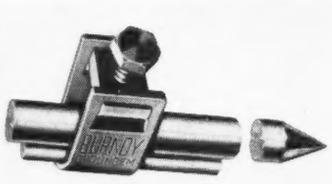
★ This complete, condensed, cross-indexed catalog will show you the one RIGHT R/M packing for every job. Call your R/M jobber or write us for your own free copy.

INDUSTRIAL SALES DIVISION
RAYBESTOS-MANHATTAN, INC.
Makers of Packings for Every Industrial Use
BRIDGEPORT, CONN. MANHEIM, PA. NORTH CHARLESTON, S. C. PASSAIC, N. J.

of india ruby mica *C* protect inner surfaces of flat glasses from etching action of steam and water. Special molded Vulcabeston gaskets *D* fit into body recesses on pressure side of glasses and provide tight joints between body and glasses without excessive tightening down of covers. Spring cones *F* attached to each cap screw limit the amount of pressure on glasses and gaskets, preventing harmful compression on glasses when covers are tightened down, taking up expansion and contraction, and allowing for slight variations in thickness of covers, glasses and gaskets. *Yarnall-Waring Co, Chestnut Hill, Philadelphia, Pa.*

Ground Connector

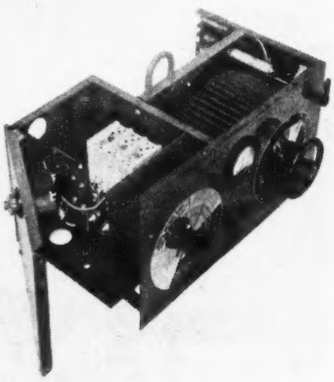
ILLUSTRATION SHOWS non-corrosive ground plant for driven rod for pipe. Can be slipped over the top of the rod as a one-piece assembly, or from the



side when head of pipe or rod has been mushroomed from driving. Available in one-half to one-inch sizes for rod and from ¼-in. IPS to ¾-in. IPS sizes for pipe. *Burndy Engineering Co, Inc, 459 E 133rd St, New York, N. Y.*

Welding Control

IMPROVEMENTS IN DUAL CONTINUOUS CONTROL for arc-welding machines, in form of new welder control box announced. New unit prevents accidental contact with live parts, increases accessibility, permits wiring with flexible or rigid conduit and eliminates dangers from unintentional loosening of lifting hook. Feature of new box is separate



It pays to clean the steam from Boiler Make-up Evaporators

By reducing impurities to less than 1 p.p.m., boiler blow down can be almost completely eliminated, thus reducing one more heat loss

W-K-M MASTER SCRUBBERS *are doing this work*

IT PAYS TO CLEAN COMPRESSED AIR, OXYGEN, AND HYDROGEN, TOO

COUPON . . . PLEASE PRINT

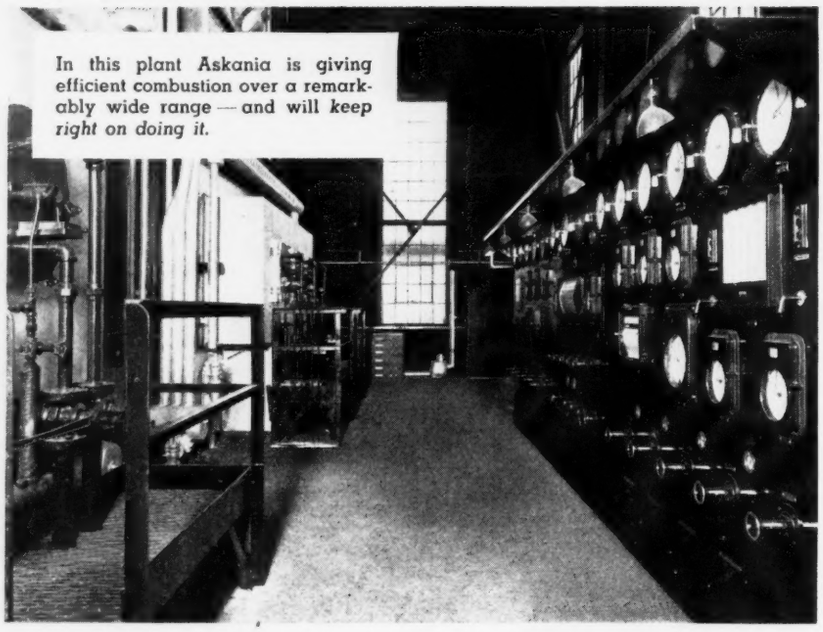
BRADSHAW & CO., 530 Fourth Ave., Pittsburgh, Pa.

Gentlemen: Without obligation, you may send me the bulletin fully describing the W.K.M. Master Scrubber, for:

____STEAM ____AIR ____GAS

Name _____ Company _____ Address _____ City _____ State _____

PLEASE PRINT



In this plant Askania is giving efficient combustion over a remarkably wide range — and will *keep right on doing it.*

The advertisement a user wrote-

A MAN who knows his power plant equipment told our story better than we can tell it. Said he:

"When I decided to pick a combustion control, I realized there were a number of them that would do a satisfactory job at the start — but I wanted to be sure we installed the kind that would stand up and do a job year after year.

"In your jet pipe you had the simplest, most accurate way I had ever seen to control anything that needed controlling. All other devices that laid claim to the same accuracy were mighty complicated, and it was easy to see that the same number of dollars buy a lot more quality in a simple machine than they can buy in a complicated machine.

"On top of that I liked the idea of using oil as an operating medium so that all parts ran in oil and there was plenty of power to operate the valves and dampers. Now I know I was right. The system *is* right and *stays* right year after year without attention or maintenance. It's the familiar story of the best being the cheapest in the long run."

We can only add that the jet pipe principle is an *exclusive* Askania principle. Ask for interesting bulletin explaining it in detail.

ASKANIA REGULATOR COMPANY
Corner 16th and Michigan, Chicago, Illinois

ASKANIA *Combustion* CONTROL

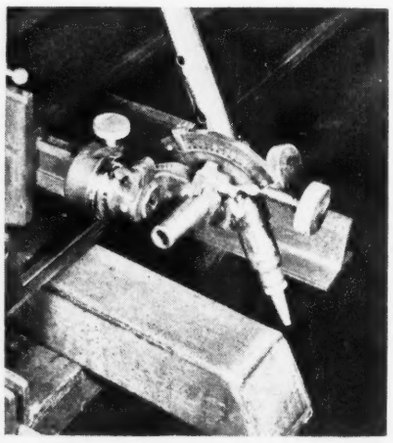
compartment for all ac circuits including pushbutton and additional compartment for dc terminals. Control box is permanently grounded to motor and generator frames through mounting bolts. This makes it possible to ground both control box and machine by simply grounding conduit which leads to box. *Lincoln Electric Co, 12818 Coit Rd, Cleveland, Ohio.*

Welding Trailer

PNEUMATIC-TIRED TRAILER for mounting all company electric-drive welders announced. Unit is designed so that welder mounting is easily accomplished by means of four bolts in trailer frame which register at four holes in legs of welding machine. Trailer is arc-welded throughout. *Hobart Bros Co, Troy, Ohio.*

Torch Holder

PROTRACTOR-TYPE TORCH HOLDER is designed for use with Radiagraph cutting torches. Protractor on machine shows



angle at which torch is set. Circular knurled knob permits angular adjustment and holder has 90-deg-angle range. *Air Reduction Sales Corp, 60 E 42nd St. New York, N. Y.*

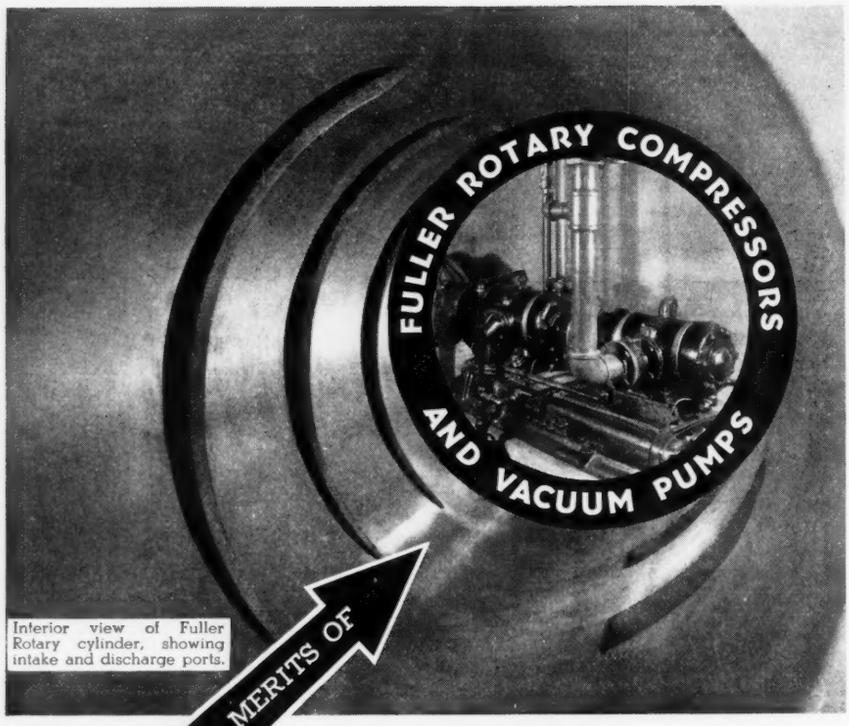
Air-Powered Pump

MODEL D AIR-POWERED MIDGET PUMP can be used in all industrial, laboratory and experimental applications where an explosion-proof unit is necessary and where compressed air is available. Pump has ¼-hp ball-bearing, vane-type, air motor, with an air consumption of 5 cfm at maximum speed. Pump impeller is mounted on end of motor countershaft, making coupling unnecessary and assuring perfect alignment. Nozzles are threaded for ¼-in. standard pipe fittings. Pumps are available

Bartlett·Snow

WEIGH LARRIES

—make it possible to keep an accurate record of the coal being fed to each boiler—prevent the segregation of coal—and permit an entire row of boilers to be supplied from a single bunker located at the end or entirely outside the building, resulting in substantial savings in building and bunker costs. Hand propelled and motor driven types in capacities from ½ ton to 20 tons per single trip. Eng. Bul. No. 83 sent on request, gives full details. The C. O. Bartlett & Snow Co., 6205 Harvard Avenue, Cleveland, Ohio.



Interior view of Fuller Rotary cylinder, showing intake and discharge ports.

LOOK INTO THE MERITS OF

SIMPLICITY of design is one of the contributing factors to the success of these efficient machines . . . a minimum of moving parts: rotor, bearings, blades. They also offer many other worthwhile features, such as:

ADVANTAGES OF—

- Direct drive
- Accessibility
- Low maintenance
- Simple foundations
- Blades automatically compensate for wear
- Maintained capacities for the life of the machine
- Comparatively small floor space with relation to capacity

ELIMINATION OF—

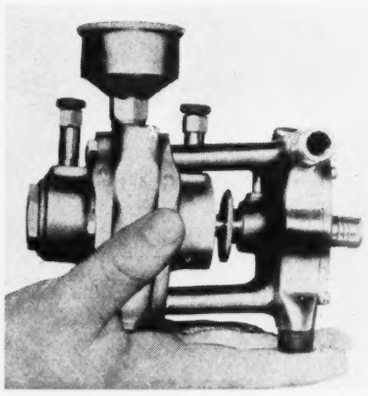
- Bearing take-up
- Unnecessary bulk
- Air-line pulsations
- Large space requirements
- Leaking valves—grinding of seats
- Multiplicity of parts requiring frequent attention, adjustment and replacement

Fuller Rotaries are built for capacities to 1800 C. F. M. actual free-air delivery, pressures to 125-lb. gauge. Vacuum pumps—for vacuums to 29.90-in. referred to 30-in. barometer.

FULLER COMPANY
CATASAUQUA, PENNSYLVANIA
Chicago: 1118 Marquette Bldg.
San Francisco: 320-321 Chancery Bldg.

C-61

FULLER
PIONEERS OF HIGH-EFFICIENCY ROTARY COMPRESSORS



in stainless-steel, monel metal, chromium-plated bronze, brass, cast iron, and other alloys. *Eastern Engineering Co, 45 Fox St, New Haven, Conn.*

Conveyor Belting

IMPROVED SHOCK-ABSORBER CONVEYOR BELTING has specially compounded layer of soft cushioning rubber between comparatively stiff abrasion-resisting cover and hard fabric belt body. Force of excessive impact and shock from falling materials at loading point is spread and dissipated by this cushion, resulting in increased service life. *Republic Rubber Div, Youngstown, Ohio.*

Packing

ASBESTOS PACKING has been designed for elevated temperatures. Known as Palmetto Cab Cock Packing, it is braided from long fibre Canadian asbestos yarn. Each strand is individually coated with dry graphite to retard fusion of asbestos and to provide an anti-friction wearing surface. Packing contains no liquid lubricant which might be boiled away. Intended for pumps and valves handling high-temperature steam, oils, and gases, and also for expansion joints, etc. *Greene, Tweed & Co, Bronx Boulevard at 238th St, New York, N. Y.*

Infra-Red Lamps

NALCO inside-silvered carbon filament lamps developed for infra-red ray processes in drying, baking, heating, and dehydrating. Polished silver in base end of the lamp acts as a reflector to project the infra-red rays toward the surface being worked on. *North American Electric Lamp Co, 1097 Tyler St, St Louis, Mo.*

6 ways Iron Fireman Stokers will help You to meet National Defense Demands

1. ***Increased Boiler Output***

Plants and buildings the country over have increased steam production 25% to 40% by installing Iron Fireman stokers in *existing* as well as new boilers. If you have increased power or heating requirements, Iron Fireman stokers will step up your present equipment to maximum output.

2. ***Widened range of dependable fuels.***

Many hand-fired boilers require special coals. Heavily taxed transportation facilities are making some coals increasingly hard to get. Iron Fireman stokers greatly widen the range of coals which you can use—make it possible for you to fire local coals if transportation from distant fields, or the use of fuels other than coal, is restricted. *You cannot afford to take the chance of a possible fuel shortage in your plant.* An Iron Fireman will help assure you a dependable, abundant fuel supply.

3. ***Decreased Labor***

An Iron Fireman automatic coal stoker greatly reduces the work of your fireman, decreases your labor cost and often releases part of the fireman's time for other work. Industrial and commercial "Coal-Flow" models feed automatically, direct from main bunker or bin to boiler. An Iron Fireman improves boiler room working conditions, too—an important factor today, when experienced firemen and engineers are hard to find.

4. ***Steady, dependable operation.***

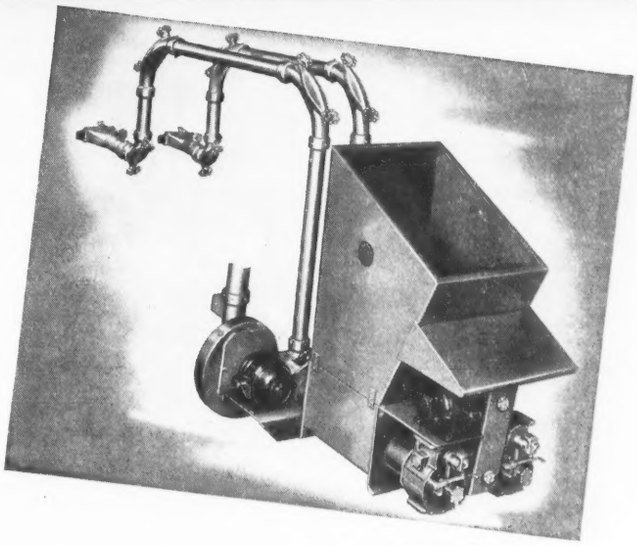
Of prime importance to you is a firm and reliable steam supply to insure constant operation, without shutdowns and delays. Iron Fireman stokers and controls are rugged. They are precision built to maintain a constant, steady steam pressure, even with widely fluctuating loads.

5. ***Installations easily adaptable to existing or new boilers.***

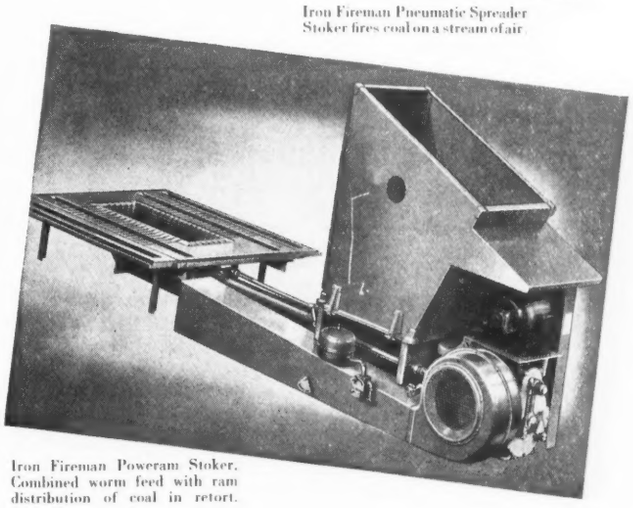
Extremely flexible and easily adaptable to existing boiler equipment, either Iron Fireman Pneumatic Spreaders or Poweram underfeed type stokers can be installed with minimum furnace alterations. Sizes are available for existing or new power and heating boilers, developing up to 50,000 pounds of steam per hour.

6. ***Low fuel costs.***

Thousands of Iron Fireman stokers are paying large dividends on the investment from fuel savings alone, by burning lower cost coal—and less coal—than with hand-firing or obsolete firing equipment.



Iron Fireman Pneumatic Spreader Stoker fires coal on a stream of air



Iron Fireman Poweram Stoker. Combined worm feed with ram distribution of coal in retort.

IRON FIREMAN

AUTOMATIC COAL STOKERS

For Power and Heating Boilers up to 50,000 pounds of steam per hour

MAIL THIS COUPON, OR WIRE OR WRITE FOR QUICK INFORMATION

IRON FIREMAN MANUFACTURING CO.
3016 West 106th Street, Cleveland, Ohio.

Gentlemen:
Please send us information on Iron Fireman stokers.

Name _____

Street and Number _____

City and State _____

23 INDUSTRIES Prove "Baerite" SIMPLIFIED

WATER TREATMENT SERVICE
FOR BOILERS AND CONDENSERS

Saves

- REPAIR AND REPLACEMENT COSTS
- DELAY AND SHUTDOWN COSTS
- MANUAL CLEANING COSTS
- FUEL COSTS • WATER COSTS
- WATER TREATMENT COSTS

A complete water service

"Baerite" Water Treatment is a highly perfected and simplified method of conditioning boiler feed waters and condenser systems, including adequate supervision and counsel. This complete service has been simplified to eliminate much of the "boiler-room-chemistry" necessary with other present-day methods and is producing results unequalled in every respect.

ASK YOUR ENGINEER IN CHARGE OF BOILER OPERATION TO GIVE YOU THE FACTS ABOUT

"Baerite" SIMPLIFIED WATER TREATMENT

WATER TREATMENT COMPANY of AMERICA
1161 HODGKISS STREET PITTSBURGH, PENNA.
Sales and Service in Key Cities

Power Lines

(*Continued from page* 134)

dard, near Keene. Similar to the project already operated by the Board near Pittsburg, N. H., the reservoirs would serve the dual purpose of flood control and water storage for hydroelectric generation.

It would cost an estimated additional $10,400,000 to provide power production equipment at the reservoir sites. Use of the reservoirs for existing hydro plant use would give an annual increase in New Hampshire power output of 300,800,000 kwhr.

OBITUARIES

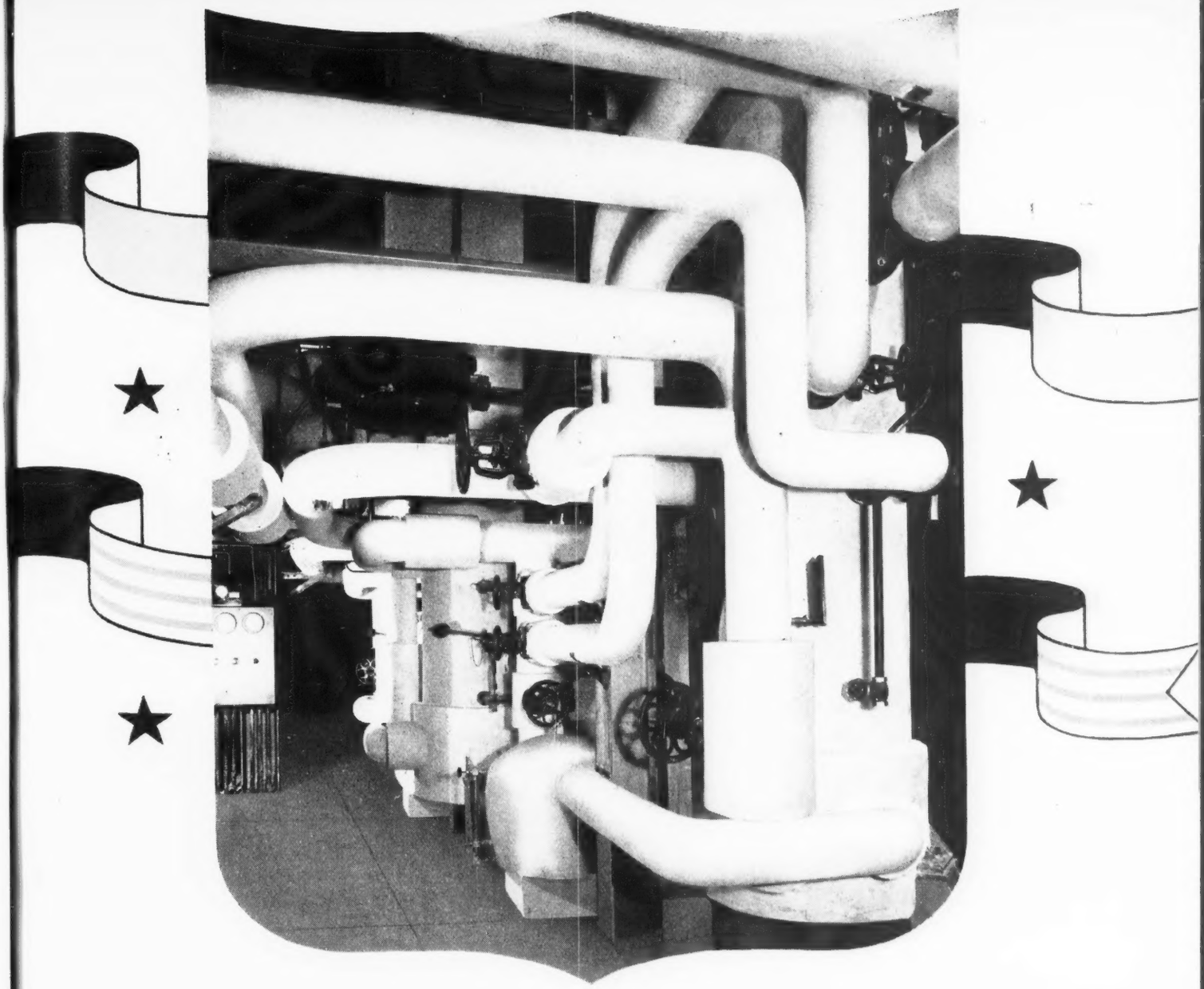
CLARENCE H KENNEDY, vice president in charge of sales, Kennedy Valve Mfg Co, died on July 21 at St Joseph's Hospital, Elmira, N. Y. following an 8-month illness. Mr. Kennedy was graduated with a degree of Mechanical Engineering from Cornell University in 1912. His entire business career was

C H Kennedy

spent with the Kennedy Co. After working through several departments, he was successively manager of the New York branch, sales manager of the company, and vice president in charge of sales. He was widely known as one of the most prominent leaders of the valve and fittings industry.

M J TENNES, chairman of the board of directors, Shafer Bearing Co, died recently. He had served as chairman of the board since 1934.

JOHN MORSE, 25, assistant manager of San Francisco branch, Fairbanks, Morse & Co, was the victim of an automobile crash recently. He was graduated from Yale in 1937, and since last April, when he resigned from the Navy



More **POWER** *to You,* **AMERICA**

Pittsburgh Piping & Equipment Company stands ready to do its part in providing more power to turn the wheels of defense industries.

Through techniques that have been proved in the past, Pittsburgh Piping can fabricate and erect all the necessary piping for complete central station systems or for extensions to existing systems in a minimum of time.

Here are complete facilities for bending, welding, machining and heat treating. Not only is considerable time saved by pre-fabricating assemblies as large as shipping and erection facilities permit, but all operations can be thoroughly checked and work cleaned and inspected for insurance before shipping. This is especially important in high temperature piping work that requires extreme care and special fabricating techniques for correct results.

But savings for Pittsburgh Piping's customers do not stop here. When each installation has been detailed by the engineering department, all units are scheduled through the shop in direct relation to the sequence of their erection in the field. Work progresses smoothly and efficiently; and installation is completed more rapidly and according to a prearranged construction program.

PITTSBURGH PIPING & EQUIPMENT CO., 10 FORTY-THIRD ST., PITTSBURGH, PA.

Woolworth Building, New York — Occidental Building, Indianapolis — Peoples Gas Building, Chicago — Union Guardian Building, Detroit
Public Square Building, Cleveland — Liberty Life Building, Charlotte — 10 High Street, Boston — 525 Market Street, San Francisco

Pittsburgh Piping

Users of CITIES SERVICE LUBRICANTS get an EXTRA ADVANTAGE with HEAT-PROVER SERVICE

Heat-Prover Service is now available to users of Cities Service Industrial Fuels and Lubricants. This is an economy measuring service which you can secure in addition to the quality and economy advantages offered by Cities Service's SERVICE PROVED Fuel and Diesel Oils.

The Heat-Prover is an ingenious device — a by-product of our research in metallurgy. It registers continuously and instantaneously changes in the amount of oxygen and combustibles in furnace gases. It is an excellent guide in adjusting 4-cycle Diesels and for combustion control in heat generating plants. In the heat treatment of metals, it is invaluable. It assures uniformity and reduces scrap losses.

Let us tell you how you can secure the use of one of these machines. Mail the coupon today for further information.

CITIES SERVICE DIESEL LUBRICANTS

FREE—Just clip and mail

CITIES SERVICE OIL COMPANY
Room 1326, Sixty Wall Tower, New York

Please tell me how I can get Heat-Prover Service in my shop. PR.

Name .....

Name of Shop .....

Address .....

City ..... State .....

because of an eye deficiency, had held the industrial position. He was the son of Col Robert H Morse, president of the company.

FRANK M GOODWIN, 67, chief engineer of the Nut Island pumping station of the Boston Metropolitan district commission, died at Beth Israel Hospital, Boston, on Aug. 30. He was a native of Springvale, Me., and had held his post for over 40 years.

EDGAR A FELDTKELLER, president of the Virginia East Coast Utilities Co, died August 28 at his home in Glenbrooke Hills, Va. Mr Feldtkeller came to Richmond from Milwaukee six years ago, and became president of the utility.

SAMUEL SMITH, 88, who retired in 1938 after about 30 years' service as operating steam engineer with the Lawrence, Mass., Gas & Electric Co, died in that city on Aug. 11.

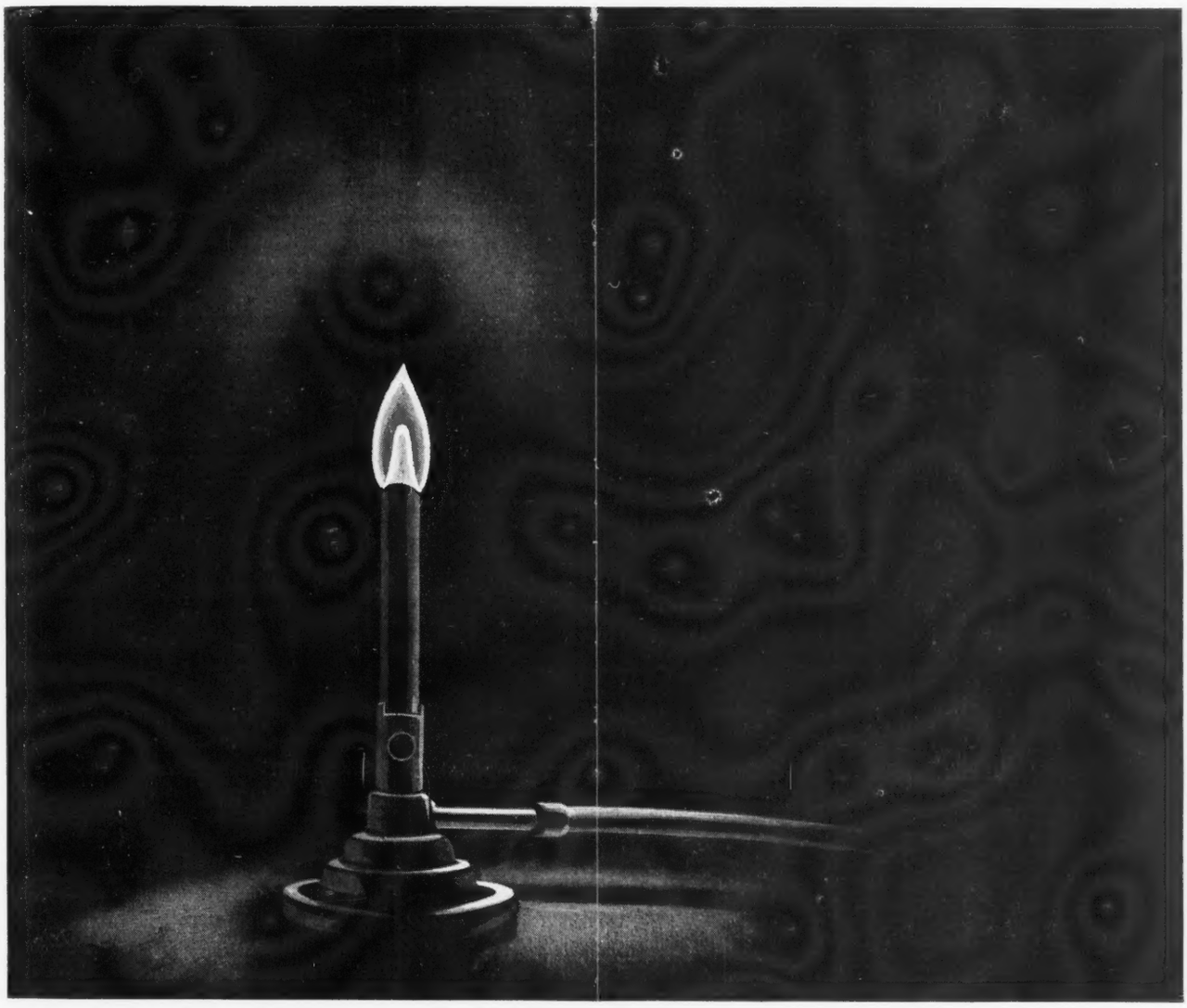
PERSONALS

J L HOLLOWAY, Crane Co, was elected a vice-president in charge of finance on August 25. Mr Holloway joined the Crane organization in 1935, was elected secretary of the company in 1937, and in addition was elected assistant to the president in 1940, a position he held until his recent appointment.

A K HEGEMAN has been appointed West Coast manager of Clark Brothers Co. He is a graduate of the University of Michigan college of mining engineering. Following his service in the Army during the last war, he became engaged in mining engineering work, until 1923. Then he joined the Smith-Booth-Usher Co, formerly the western representative of Clark. New sales offices of the company are located at the plant of Pacific Pump Works, Huntington Park, Calif.

VICTOR A HANSON was made, effective August 14, general sales manager of the Whitney Chain & Mfg Co. He was formerly assistant sales manager and field manager of the company.

L W WALLACE, research and management engineer, has joined the staff of the Trundle Engrg Co, as vice president. Before accepting the position, he was director of engineering and research of the Crane Co, Chicago. He has served for some years as executive secretary of the American Engineering Council, and director of engineering and research of



ALL THE LIGHTS HAVE *NOT* GONE OUT...

In thousands of laboratories . . . despite the national emergency . . . men work on with the pale flame of the Bunsen burner. For this is the lamp of research, that lights our road and lightens our load. Knowing there will always be a tomorrow, the men with the burner keep looking for better ways of alloying steel, better ways of baking bread, better ways of making dyes, better ways of doing everything.

Today national defense requirements come first with us as they do with you. The Keasbey&Mattison plants are tremendously busy with defense orders; even with new machines, more men and plenty of overtime we find it increasingly difficult to deliver certain products needed by customers in non-defense industries. Yet we realize the necessity for constantly improving our products, for giving you better asbestos materials . . . in the future.

What can we do to make asbestos serve you better when more normal times return? Our research laboratories are busy now, as always, seeking ways of making new and better products, but your specific problems are of the utmost importance to us. Would a change in one of our products help you in overcoming some difficulty that arises in your work? We want your problems for our men with the Bunsen flame. We will give every suggestion thorough consideration in the hope that it will prove practical from a manufacturing standpoint. May we have a letter from you?

Nature made asbestos; Keasbey & Mattison has made it serve mankind—since 1873.

KEASBEY & MATTISON
COMPANY, AMBLER, PENNSYLVANIA

SAVE TIME—REDUCE A MAJOR WORRY

1. Dixon's Ticonderoga Flake Lubricating Graphite is unaffected by heat, pressure, solvents, excess moisture. Lubricates where other lubricants fail. Mixed with oils and greases it lends added lubricating and endurance qualities. THAT MEANS ANY GIVEN LUBRICATING JOB NEED BE DONE LESS OFTEN.

2. Alone or in mixture, this pure, natural flake graphite impregnates wearing surfaces with a durable, microscopically thin lubricating film that often prevents costly, schedule-wrecking damage when periodical lubrication is neglected. THAT MEANS LESS WORRY ABOUT MAINTENANCE SUPERVISION, LESS FEAR OF PRODUCTION INTERRUPTIONS.

DIXON'S TICONDEROGA FLAKE LUBRICATING GRAPHITE—Particle Size No. 1—large, lubricous flakes. Particle Size No. 2—finely subdivided, powdered flakes.

DIXON'S NO. 635—Minutely subdivided particle size for close tolerances.

DIXON'S MICROFYNE POWDERED GRAPHITE—Microscopically subdivided particle size for mixing with oils and greases, also "shot" through handy Dixon's Graph-Air Guns for dry lubrication of locks, small tools, etc. Can't drip, gum, nor collect dust.

DIXON'S GRAPH-AIR GUNS

are ideal for lubrication of locks, small tools, etc. A squeeze shoots MICROFYNE Powdered Graphite, which cannot drip, freeze or gum, straight to sources of friction. "CUB", 200 shots, 10¢. "JUNIOR", 900 shots, 30¢. "SENIOR", giant-size rubber refillable model, 75¢ filled.

DIXON'S CUP AND PRESSURE GUN GRAPHITED GREASE

is available in six consistencies, each maintained over an unusually wide temperature range.

DIXON'S L&P (LUBRICATING AND PENETRATING) GRAPHITED OIL

quickly frees rust-frozen bolts and other threaded assemblies, lubricates and prevents future corrosion. Graphite content makes it "stay put" longer.

GRAPHITE EXCELLENCE SINCE 1827

JOSEPH DIXON CRUCIBLE CO.

Jersey City, New Jersey

648

the Association of American Railroads. He has held executive positions with Diamond Chain & Mfg Co, the W S Lee Engrg Corp, and the Crane Co.

LEONARD F LANG has been appointed to newly organized Power Plant Dept. Western Precipitation Corp, Los Angeles. Mr Lang is a member of the American Society of Mechanical Engineers; has had 24 years experience in

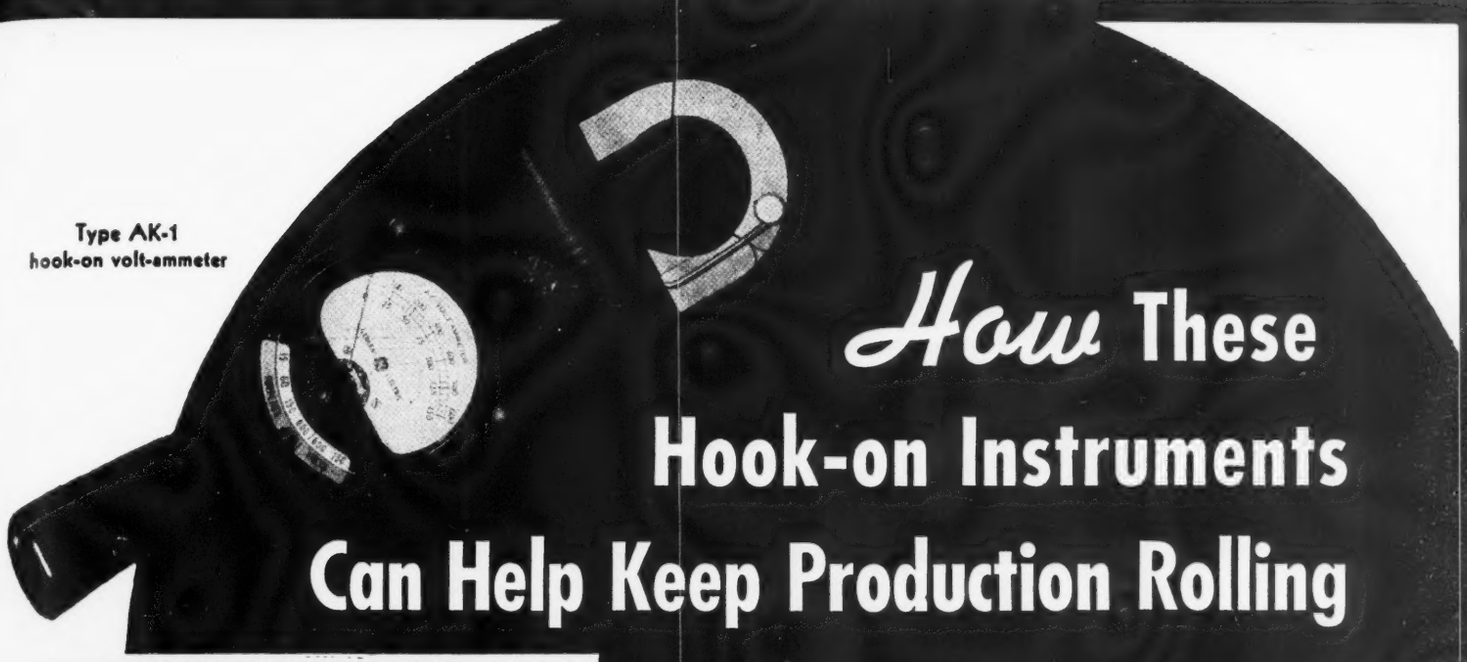
Leonard F Lang

the design, manufacture and operation of large industrial stoker applications throughout the Midwest. For the past 12 years he has been associated with the Chicago office of the Detroit Stoker Co. and in his new position will have offices at 140 S Dearborn St, Chicago.

A A BROWNE, steam engineer for Westinghouse for the past two years, has been appointed assistant manager of the Company's central station and transportation divisions for the Pacific Coast district. Mr Browne will make his headquarters in San Francisco. As district steam engineer, Mr Browne has had wide experience with almost all phases of the electrical industry, particularly with large steam turbines.

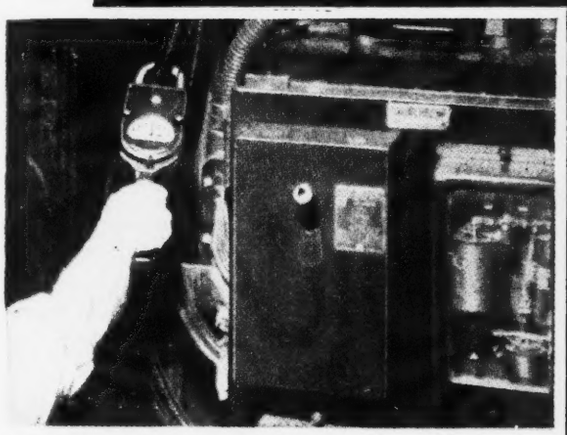
Appointment of W M BALLENGER to position of assistant district engineer of General Electric's central district was announced. Mr. Ballenger has been a member of the company's central district application engineering section since 1928, specializing in steel mill and associated industrial problems. He has been associated with General Electric since 1923.

D G BAXTER is appointed general superintendent in charge of Copperweld Steel Co's Warren, Ohio, plant. Mr Baxter is a graduate of Ohio Northern University and is widely known in the steel business. He has previously been associated with American Steel & Wire Co. Pittsburgh Crucible Steel Co. Re-

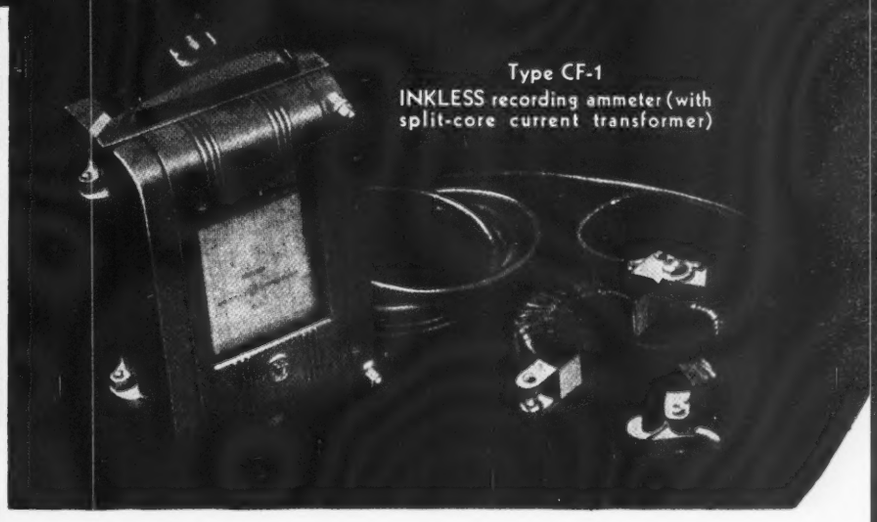


Type AK-1
hook-on volt-ammeter

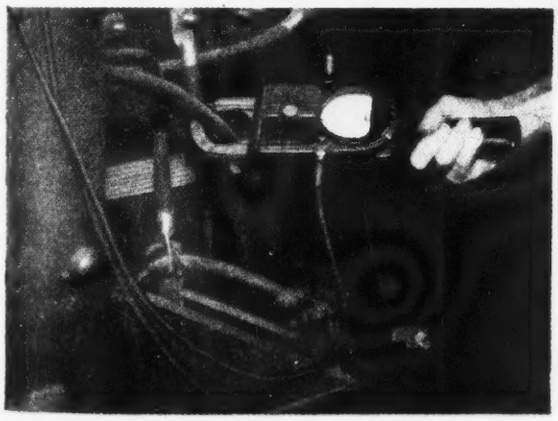
How These Hook-on Instruments Can Help Keep Production Rolling



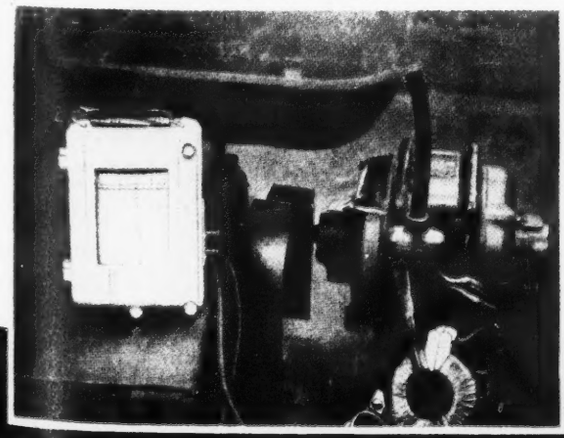
The AK-1 is made for tight places. Here it is being used for a quick, easy measurement of voltage-regulator current.



Type CF-1
INKLESS recording ammeter (with split-core current transformer)



Measuring a-c VOLTS and AMPS. Hook it around a conductor to measure amperes. Connect the voltage leads (as shown above) to measure volts. With this one setup, you can make either measurement just by flicking the selector switch.



Checking motor load with the CF-1 recording ammeter and split-core current transformer.

1. **The ease of making tests encourages routine testing and promotes good maintenance, which prevents production delays.**

2. **Emergency tests can be made without cutting conductors—thus avoiding shutdowns.**

TODAY, when motors and other electric equipment are being taxed to the limit and may be overloaded, frequent testing of circuit conditions will often avert serious production delays. These instruments will take care of almost all your testing work.

The volt-ammeter is ideal for emergency tests where a fast check of circuit conditions is needed. It measures both VOLTS and AMPERES. Having six a-c ranges, it's really six instruments in one —0-15/60/150/600 amperes and 0-150/600 volts.

The INKLESS feature of the recording ammeter makes it the handiest of recorders for general plant maintenance. With no pen to start and no inkwell to fill, it's ready to be hooked around a conductor and start recording at a moment's notice.

You're overlooking a good bet if you don't have both these handy G-E instruments for emergency and maintenance testing.

For complete information on the volt-ammeter, ask for Bulletin GEA-2950; on the recorder, GEA-3187. Your G-E office has copies. General Electric, Schenectady, New York.

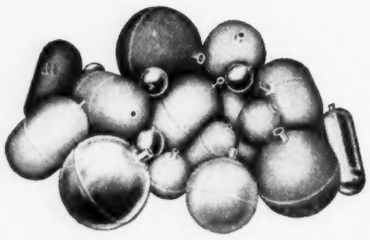
GENERAL ELECTRIC

NICHOLSON

HIGH PRESSURE WELDED FLOATS—Stainless Steel-Chromium Plated Steel

Available for all applications—for steam pressures up to 1500 lbs. and hydrostatic pressures up to 2500 lbs.—for corrosive and non-corrosive service.

Made in spherical and elliptical shapes in sizes from 2½" to 14" diameter. High in tensile strength and offer great resistance to external pressure. Special sizes and shapes available to order, and also cadmium, nickel or copper plated. Fully described in Bulletin No. 339.



2-, 3- or 4-WAY CONTROL VALVES for SINGLE and DOUBLE ACTING CYLINDERS

Special types also available.

Designed for long life, quick and dependable control of air, steam, oil, gas or water on pressures up to 300 lbs.

Made also in foot, solenoid and motoroperated types—also balanced valves for high pressure hydraulic serv.ce. Ask for Bulletin No. 933 for details.

OTHER PRODUCTS

NICHOLSON Industrial Steam Traps, Piston and Weight Operated Traps, Flexible Couplings, Expanding Mandrels, Arbor Presses, Compression Shaft Couplings, Steam Eliminators and Separators, Compressed Air Traps.

W. H. NICHOLSON & COMPANY
125 OREGON ST. WILKES-BARRE, PENNSYLVANIA, U. S. A.

MASED LUBRICANT No. 177

for Bearing LUBRICATION in the HOTTEST Service Spots!

Economical, dependable maintenance of ball and roller bearing efficiency is assured at operating temperatures up to 500° Fahr.

Of a buttery consistency at room temperature, MASED LUBRICANT No. 177 defies the usual liquifying action of heat. *Give it a HOT SPOT test!* Center a piece of pea size on an electric hot plate! MASED *remains* buttery while other greases melt and run away.

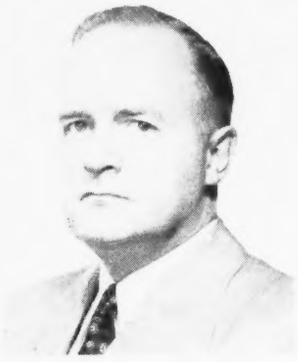
MASED LUBRICANT No. 177 has a definite place in the lubrication of textile drying machinery, kiln and oven cars and innumerable types of equipment subjected to high temperature conditions.

● *Get more facts about this unusual Lubricant.*

BORNE SCRYMSER COMPANY
ESTABLISHED 1874
17 BATTERY PLACE • NEW YORK

public Steel Corp, and the National Tube Co.

HOWARD M HUBBARD has been elected president of Elliott Co, effective September 1. Mr Hubbard comes to Elliott from Greenfield Tap & Die Corp, Greenfield, Mass., where he was president and general manager. Previous to his association with that company, Mr Hubbard served in various capacities with the Harris-Seybold-Potter Co of Cleveland, Ohio.



Howard Hubbard

BUSINESS ITEMS

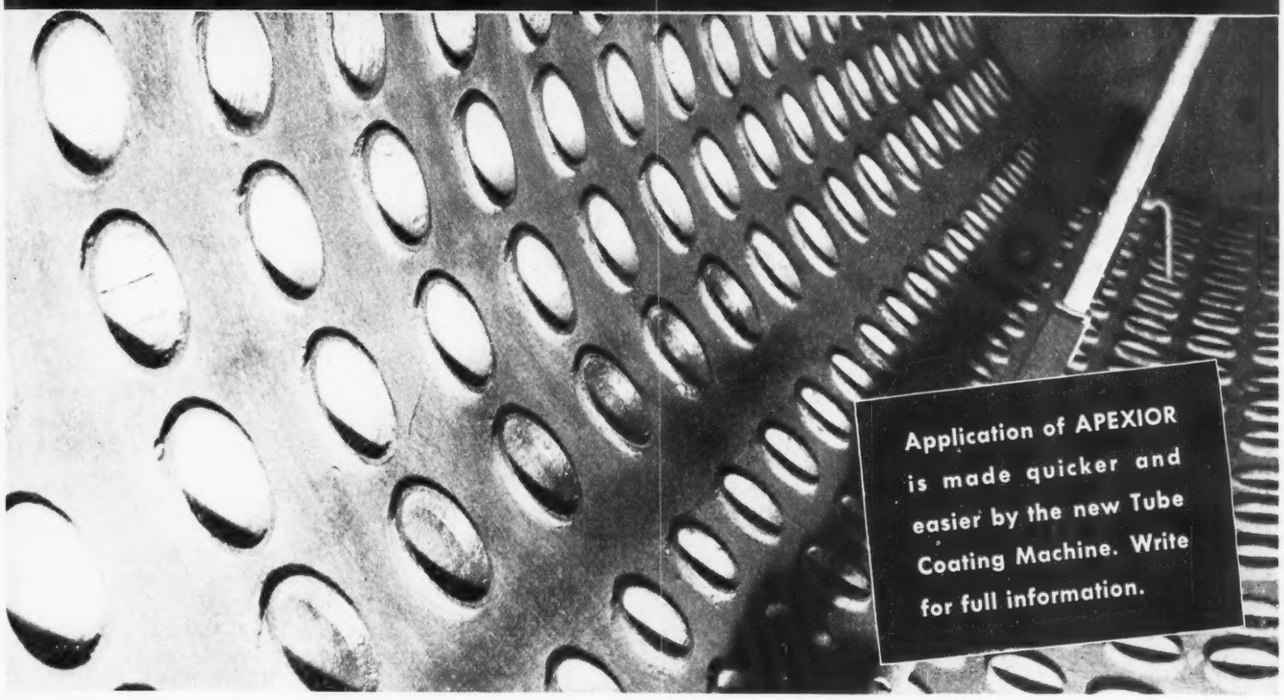
FEDDERS MFG CO, Buffalo, N. Y. announces appointment of Clarence E Scott as sales manager of its Air Conditioning Div. He takes the sales position formerly held by E R Walker, who has been promoted to assistant general manager.

UNION CARBIDE & CARBON CORP has elected Fred H Haggerson a director. He is a vice-president of Union Carbide & Carbon Corp, president of Union Carbide Co, and president of the companies in the Electro-Metallurgical group. Mr Haggerson has been with the corporation for more than 20 years.

Several appointments on factory staff of B F GOODRICH CO were announced recently. J E Gulick has been named factory manager of Los Angeles Div. succeeding J C Herbert, assistant secretary of the Lone Star Defense Corp. defense subsidiary of the company. Fred A Nied succeeds Gulick as manager of Interplant Operations Dept. Frank Trockle is named acting general superintendent of Mill 4, succeeding Arthur Kelly, who becomes general manager of the defense corp. L K Starkweather assumes Trockle's duties as production superintendent of Mill 4. J J Feeley is named assistant manager

3 Times as Much Steam...

WITHOUT EXTRA WEAR ON BOILER METAL



Many boilers are being called on to supply steam around the clock — instead of on a one-shift basis as formerly.

You can get more positive protection against early corrosion of boiler metal . . . and eliminate extra cleanings that you would normally expect—by supplementing your water treatment with an APEXIOR coating.

Recommended by all U. S. and Canadian boiler insurance companies. Write for Bulletin 1290.

APEXIOR *will save you two ways:*

1. prevent corrosion in new boilers; effectively check it (after cleaning) in old boilers — for up to 3 years between renewals.

2. make boiler cleaning easier — and less often necessary — by preventing tight adherence of water scale.

Start the defense of your boiler metal now by applying APEXIOR. It will help your boilers stand up under extreme operating requirements. It may be the means of keeping in service certain old boilers otherwise due for replacement. It will certainly reduce outage periods for tube cleaning.

APEXIOR
REG U.S. PAT. OFF.

THE DAMPNEY COMPANY OF AMERICA

PROTECTIVE COATINGS FOR STATIONARY BOILERS, LOCOMOTIVES AND STEAMSHIPS

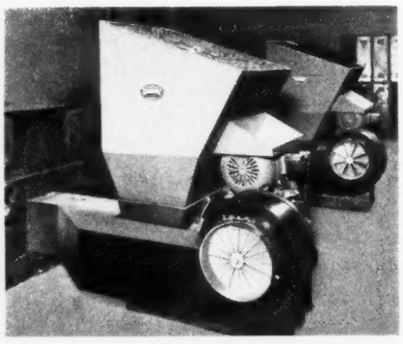
HYDE PARK · BOSTON · MASSACHUSETTS

Atlanta Chicago New York Detroit Philadelphia

Engineering Sales Representatives — Pittsburgh, Cincinnati, New Orleans, San Francisco, Los Angeles, Portland, Seattle, Phoenix, Denver, Salt Lake City, Dallas, Houston, Vancouver, B. C., Montreal, P. Q., Havana, Cuba, Manila, P. I., Honolulu, T. H., Marine Dept., 114 Liberty Street, New York, N. Y.

a lot of REPUTATIONS WERE MADE on these INDUSTRIAL STOKERS!

. . . ours, and those of some thousands of engineers and industrial executives—to whose judgment the first-rate performance of Frederick Stokers has been a year-in-year-out tribute!



For heavy duty operation, the unusual mechanical simplicity of the Frederick Stoker has decided advantages —well demonstrated in 23 years' use —pertinent to your problem today. There's a size and type for practically any requirement . . . for bituminous or anthracite. Ask about them; no obligation.

Frederick
INDUSTRIAL STOKERS

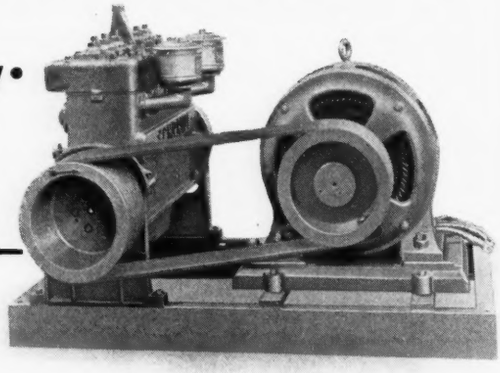
Product of The FREDERICK IRON & STEEL CO., Frederick, Maryland . . . "Builders of Good Stokers for Over 23 years."

COMPLETE LINE OF CENTRIFUGAL PUMPS FOR ALL PURPOSES
STEAM OPERATED ASH CONVEYING SYSTEMS • ASH STORAGE BINS

AIR WHERE YOU NEED IT

• Quickly • Easily •

At minimum cost



Our 16 page engineering bulletin 3907 gives complete details and specifications. Write for your copy today.

"V" BELT DRIVE

SCHRAMM Stationary Air Compressors provide the means of supplying compressed air service right where it's needed for maximum convenience and use.

SCHRAMM, INC., WEST CHESTER • PA.

SCHRAMM Air Compressors

of Labor Dept. and will assume the duties of A C Sprague.

WHEELCO INSTRUMENTS CO. has, due to increasing business volume, moved to own building. New home is Wheelco Bldg. Harrison & Peoria Sts. Chicago, Ill.

KEYSTONE CARBON CO. St Marys, Pa., has just completed large addition to factory, to be used for manufacture of brushes and line of porous bearings.

CHAIN BELT CO is observing 50th anniversary this year, having been founded on Sept 9, 1891. Illustrated brochure, The Rex World, gives early company history in pictures, and shows numerous ways in which company products are serving today.

E J CHENEY CO. 61 Broadway, N. Y. consulting engineers, was erroneously described in this department of the September issue of POWER as having just opened new offices. Actually the company has been serving industry since 1920, as new brochure points out.

CHAPLIN-FULTON MFG CO announces that Blanchard Smith will represent them in the Mid-Continent territory. Mr Smith's territory will comprise eight states, including Iowa and Nebraska on the North, and Louisiana and Texas on the South. He will make his headquarters in Kansas City, Mo.

DETROIT REX PRODUCTS CO. Detroit, Mich., announces, effective Sept 1, that S A Harris has been appointed eastern regional manager. W F Newberry, formerly holding that position, has been promoted to the general office at Detroit on special duties.

COCHRANE ENGRG CO. W Jackson Blvd, Chicago, Ill., has been appointed

MEETINGS

American Institute of Chemical Engineers —*34th Annual Meeting, November 3-5, Cavalier Hotel, Virginia Beach, Va.*

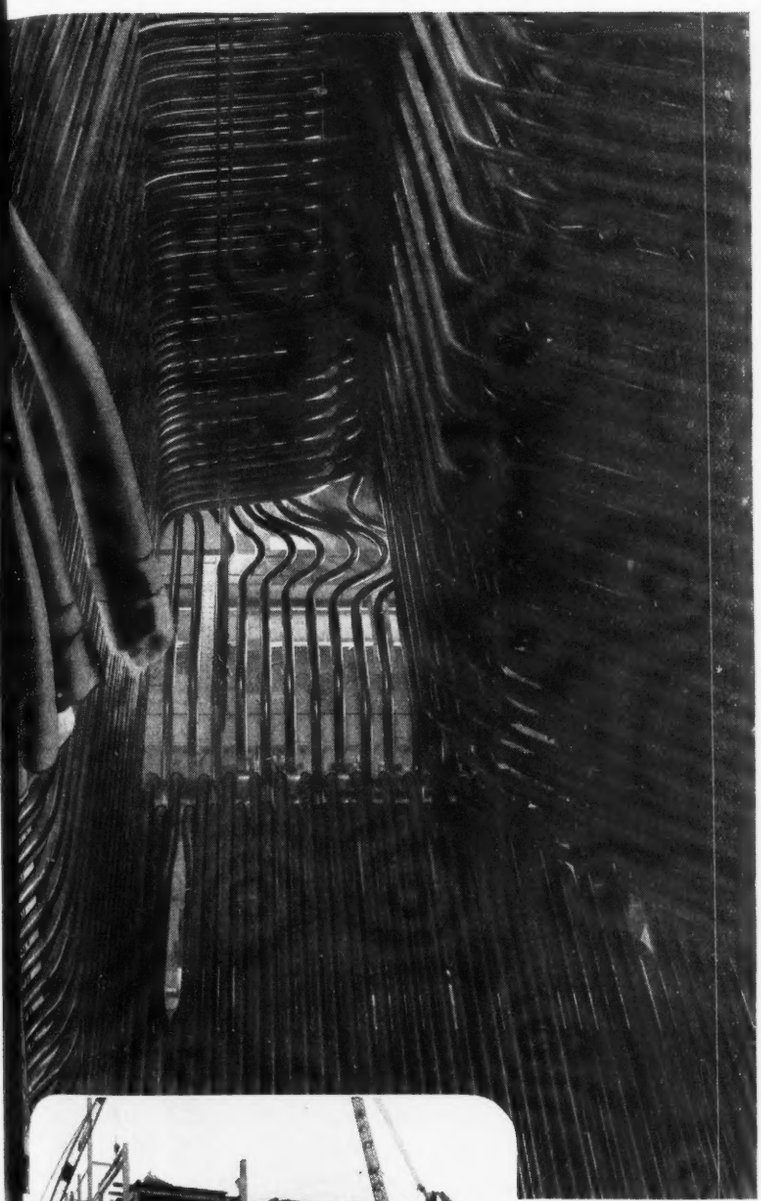
American Society of Mechanical Engineers —*Fall Meeting, Louisville, Ky., October 12–15, 1941. Joint meeting ASME Fuels and AIME Coal Divisions, Lafayette College, Easton, Pa., October 30–31, 1941. Fall Meeting, Brown Hotel, Louisville, Ky., October 12–15. C E Davies, secretary, 29 West 39th St, New York, N. Y.*

National Council of State Boards of Engineering Examiners — *Annual Meeting, October 27–30, Hotel Pennsylvania, New York, N. Y.*

International Heating & Ventilating Exposition —*7th Annual Exposition, in conjunction with 48th Annual Meeting, American Society of Heating and Ventilating Engineers, Commercial Museum, Philadelphia, Pa., January 26–30, 1942.*

Again—It's ELECTRUNITE

—for the new $6,500,000 City of Cleveland Light Plant!



Rising high above the waters of Lake Erie, which adjoin it, is a new, huge power plant —the Lake Road Generating Station of the Department of Public Utilities of the City of Cleveland, Ohio.

And in its three, 3-drum Foster-Wheeler steam generators arranged for continuous capacity of 300,000 lbs. of steam per hour at 665 lb./sq. in. pressure and 835° temperature are approximately 140,000 feet of Republic ELECTRUNITE Boiler Tubes.

Again, ELECTRUNITE was the choice. And again, according to records of performance in other installations in all types of boilers, they will show the way to safe, low-cost operation.

You can't afford shut-downs and high maintenance costs—but you can afford Republic ELECTRUNITE Tubes. They're easy to install and dependable in service because they are produced by Republic's proved electric resistance welding process—because they are free from scale and scale pits—because every tube is hydrostatically tested far in excess of code requirements. Write for literature. Steel and Tubes Division, Republic Steel Corporation, Cleveland, Ohio.

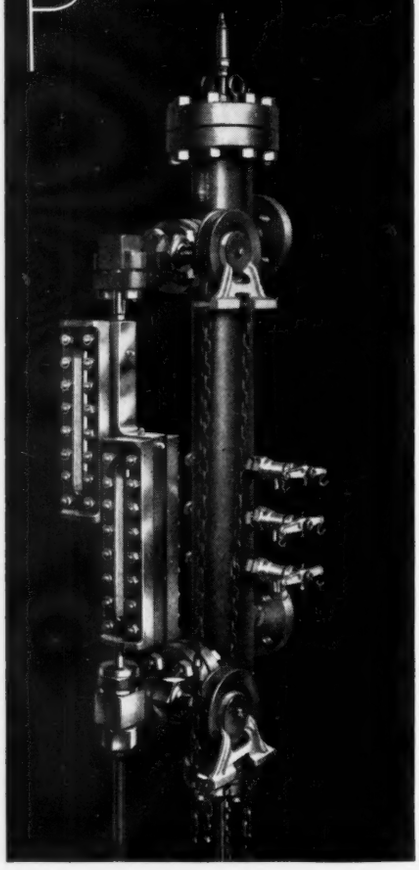
REPUBLIC STEEL — DEFENSE FOR AMERICA

Republic ELECTRUNITE

REG. U. S. PAT. OFF.

Electric Resistance Welded Boiler, Condenser and Heat Exchanger Tubes

POSITIVE
Protection



Yarway's unique Hi-Lo Alarm mechanism utilizes balanced *solid weights* that are as indestructible and unchanging as the metal itself. Operating on the displacement principle, they literally "weigh the water level."

When the high or low water emergency occurs—instant, positive, powerful, hair-trigger *action* results—giving warning of danger by whistle, light, or both.

Yarway Water Columns, eight standard models, iron bodies with screwed connections for pressures up to 250 lbs., forged steel bodies with flanged connections for pressures up to 1500 lbs., are fully described in Catalog WG-1807. Write for a copy and working model.

YARNALL-WARING COMPANY
100 Mermaid Ave. Philadelphia

YARWAY
FLOATLESS HI-LO ALARM
WATER COLUMN

by American Engineering Co, Philadelphia, as sales representatives in Northern Illinois, Northern Indiana, and Iowa. G J Zanka of the Chicago office of American Engrg Co is now associated with the Cochrane Co.

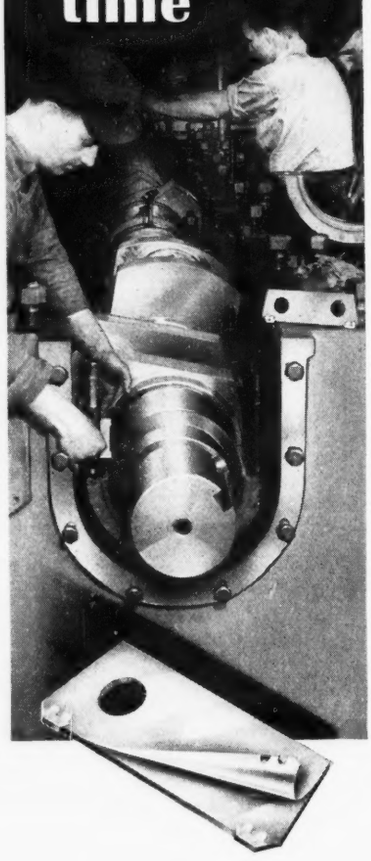
ALLIS-CHALMERS MFG CO announces several personnel changes: F W Bush has been appointed assistant to manager of Electrical Dept, and J F Sellers has been appointed engineer in charge of dc design. Sales Section of Transformer Div will be divided into two sections with G W Clothier in charge of transformer sales and R Bell in charge of feeder voltage regulator sales. O K Marti has been made consulting engineer of company's Rectifier Div, being relieved of routine duties to devote his time to research and development work. H Winograd, who studied under Mr Marti at Cornell, is appointed engineer in charge of Rectifier Design.

BAILEY METER CO announces opening of Detroit branch office. This office, located in Curtis Bldg, is under management of N M Barnett, assisted by R F Hanson and R T Cowan.

CHAIN BELT CO, Milwaukee, Wis., announces several changes: W B Marshall, who has been assistant sales manager of Conveying and Engineering Products Div, has been made sales manager of that div. B E Sivyer, former San Francisco branch manager, has been transferred to Milwaukee as assistant sales manager of Chain Belt and Transmission Div. Replacing him at San Francisco is S Y Warner, who joined the company in 1930.

ALLIS-CHALMERS MFG CO announces the appointment of S E Tray as acting manager of its Feedwater Treating Department, effective September 1st. Mr Tray, assistant manager of this department for the past three years, will succeed Mr Otto H Falk, Jr, who has resigned. The new department head joined the Allis-Chalmers organization at the time the Feedwater Treating Department was formed in 1932. Expansion since that time has provided the department with field representatives in 10 district offices and a service that covers the leading industrial plants and utilities of the country.

release
machine
time

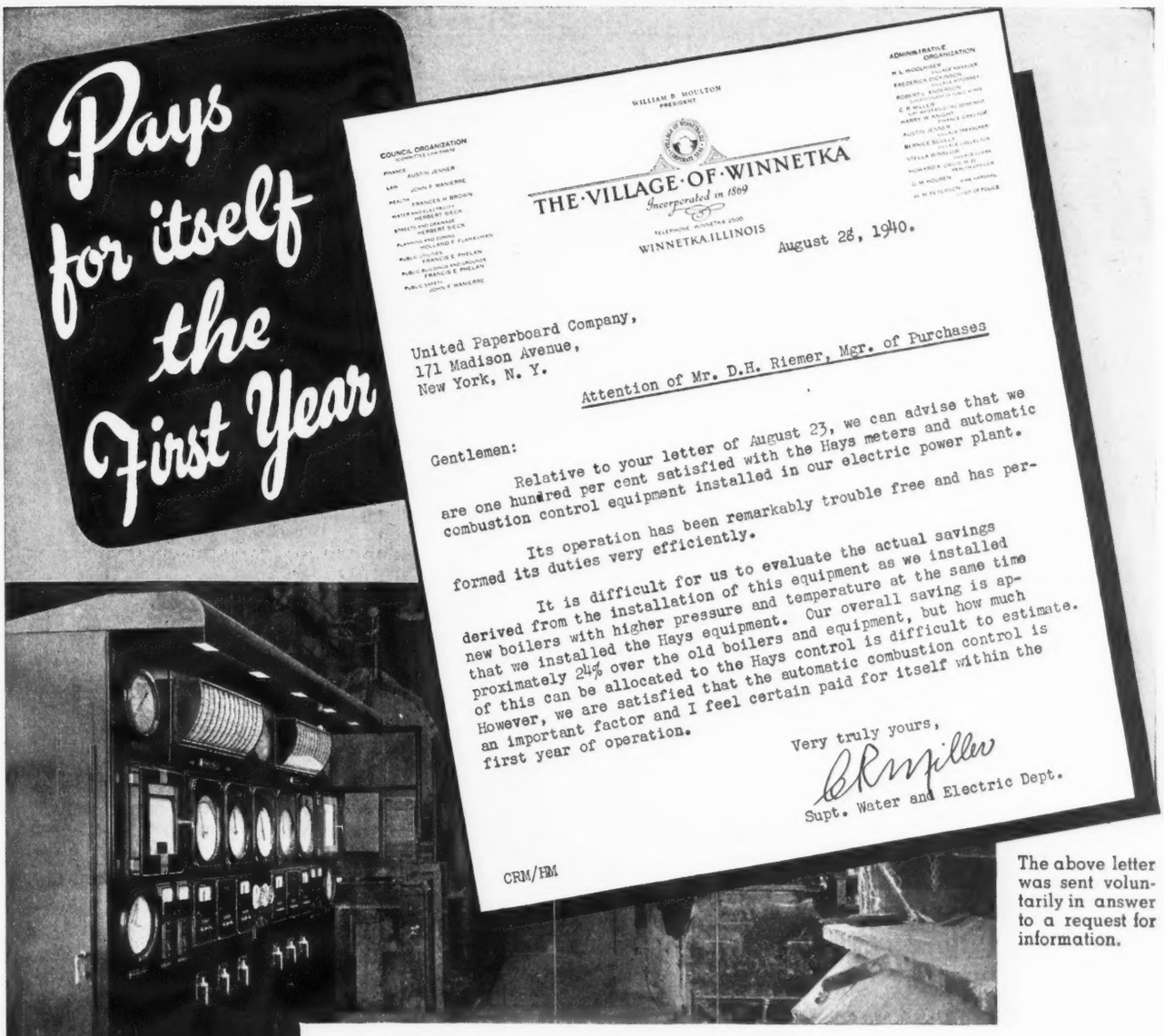


Increase available machine time 20 to 30% by designing your product for LAMINUM shim adjustment. Permits greater flexibility in assembly. ...This gas and Diesel engine builder simply *peels* his Laminum shims. Provides quick accurate clearance for main and connecting rod bearings and compressor cylinder crossheads. Correct adjustments in assembly and for engine life! Note the babbitt-tipped type of shim used...for oil and pressure seal.
• *Shims (.002 or .003 in. thick laminations) cut to your order. For repair or maintenance work, get stock sheets or strips from your mill supply dealer.*

Laminated Shim Company
INCORPORATED
61 Union St. Glenbrook, Conn.
Write for file-folder of shim application photos — and Laminum sample.

LAMINUM
THE SOLID SHIM THAT peels FOR ADJUSTMENT
1663

Pays for itself the First Year



WILLIAM B. MOULTON
PRESIDENT

COUNCIL ORGANIZATION

ADMINISTRATIVE ORGANIZATION

THE·VILLAGE·OF·WINNETKA
Incorporated in 1869

TELEPHONE WINNETKA 2500
WINNETKA, ILLINOIS

August 28, 1940.

United Paperboard Company,
171 Madison Avenue,
New York, N. Y.

Attention of Mr. D.H. Riemer, Mgr. of Purchases

Gentlemen:

Relative to your letter of August 23, we can advise that we are one hundred per cent satisfied with the Hays meters and automatic combustion control equipment installed in our electric power plant.

Its operation has been remarkably trouble free and has performed its duties very efficiently.

It is difficult for us to evaluate the actual savings derived from the installation of this equipment as we installed new boilers with higher pressure and temperature at the same time that we installed the Hays equipment. Our overall saving is approximately 24% over the old boilers and equipment, but how much of this can be allocated to the Hays control is difficult to estimate. However, we are satisfied that the automatic combustion control is an important factor and I feel certain paid for itself within the first year of operation.

Very truly yours,

Supt. Water and Electric Dept.

CRM/HM

The above letter was sent voluntarily in answer to a request for information.

A MUNICIPAL light plant in a mid-western city, through a modernization and expansion program including Hays Automatic Combustion Control, improved its operating efficiency around 24%. Steam pressure was raised from 225 lbs. to 450 lbs., total temperature from 500° F. to 750° F. and fuel consumption per kw.-hr. output was reduced from 2.32 lbs. to 1.73 lbs. Efficient and economical combustion with practically no smoke or fly-ash is maintained by the Hays Automatic Control as well as a constant steam pressure regardless of load fluctuations.

Hays Engineering organizations throughout the country are ready to advise you how automatic combustion control may be able to improve the operating conditions in your own power plant—no obligation. Write us.

NOTE TO ENGINEERS:

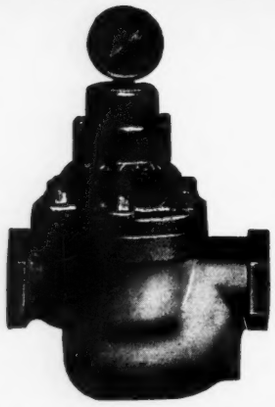
Tear off the bottom of this ad and mail with your name and address to Hays Corporation and we will send you a copy of "Automatic Combustion Control and Its Relation to Lower Steam Costs."

The HAYS CORPORATION

SINCE 1901 — COMBUSTION INSTRUMENTS AND CONTROL — MICHIGAN CITY, INDIANA, U.S.A

ADVERTISING PAGES REMOVED

HENSZEY
BOILER FEED WATER METERS

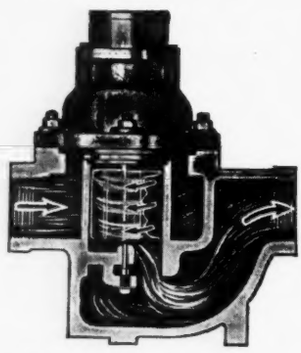


WHAT THEY ARE:

Henszey Boiler Feed Water Meters are specially designed measuring instruments constructed on the vortex principle. They have a minimum of moving parts built to stand the severe service expected of them. There are no close clearances.

WHAT THEY DO:

Henszey Boiler Feed Water Meters accurately measure hot, dirty boiler blowdown, boiler feed water, condensate, free running chemicals and other "hard-to-measure" liquids. They are equally accurate at high or low flow, high or low pressure, on reciprocating, duplex, triplex or centrifugal pumps.



HOW THEY DO IT:

Water enters the measuring chamber tangentially, spinning in the chamber as it passes through, forming a vortex. Each gallon that passes through this chamber makes the same number of revolutions of the water. A vane is placed in the rotating water to impart this rotation to the register.

WHERE TO USE THEM:

Measure boiler blowdown, boiler feed water, chemicals or any other liquids that are hard to measure. Sizes from 10 g.p.m. to 1200 g.p.m. cold water steady flow rating. Pipe connections ¾" to 6". Can be calibrated in gallons, pounds, or cubic feet at any specified temperature.

If you have a special measuring problem send it in—you'll get a practical answer.

HENSZEY COMPANY
Dept. D10 Watertown, Wis.

New Bulletins

BOILERS AND ACCESSORIES

1 REFRACTORY—Johns-Manville, New York, N. Y. 4-page folder describes Firecrete, refractory for furnace covers and bottoms, door linings and other monolithic refractory construction.

2 REFRACTORY—Harbison-Walker Refractories Co, Pittsburgh, Pa. 6-page folder reports mineral constitution, chemical composition, strength, spalling resistance and other features of Korundal, as well as chart which shows melting point of alumina-silica refractories.

3 BOILERS — Kewanee Boiler Corp, Kewanee, Ill. Catalog 80k is a condensation of data appearing in 16-page Catalog 88k; it includes specifications, cuts and diagrams of Square Type "R" boiler for heating large and moderate size homes and smaller buildings.

4 DUST COLLECTORS—Pangborn Corp, Hagerstown, Md. 6-page folder describes operation of unit-type dust collector with typical installations and photographs of individual parts.

5 PROPERTY CHART—American Lava Corp, Chattanooga, Tenn. Wall-chart gives specific gravity, density, volume, color, hardness and other properties of ceramic insulating materials, including Steatite, Cordierite and lava bodies.

ELECTRICAL EQUIPMENT

6 ELECTRICAL SPECIALTIES—Ideal Commutator Dresser Co, Sycamore, Ill. 84-page catalog gives instructions on care of motors and other maintenance equipment with photographs, diagrams and tables. Also illustrates and describes line of company's electrical specialties.

7 ELECTRIC SETS—Caterpillar Tractor Co, Peoria, Ill. 8-page booklet, "Power for Industrial Plants", portrays diesel-engine and electric installations producing all power needed on full-time jobs, serving as a power auxiliary and as standby units.

TRANSFORMERS — Westinghouse Elec & Mfg Co, Dept 7-N-20, East Pittsburgh, Pa. Booklet B-2304 answers questions about advantages, safety features, design, size and weight, maintenance and application of air-cooled transformers for factories, mines, and central stations.

9 CONDUIT SYSTEMS—H W Porter & Co, Newark, N. J. illustrates monolithic "sidewalk" base, internal channel drain, arch and tile construction, provision for various types of insulation, adaptability and accessibility of Therm-O-Tile underground steam conduits, to take care of all pipe sizes and any number of pipes.

HEATING, VENTILATING & AIR CONDITIONING

10 AIR CONDITIONING — Frick Co, Waynesboro, Pa. 8-page bulletin No. 100-B explains with photographs and diagrams basic design, application, size, speed, etc of company's refrigerating machines.

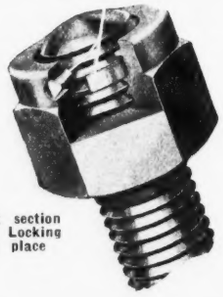
11 ENGINE-COMPRESSOR — Worthington Pump & Machinery Corp, Harrison, N. J. 18-page bulletin S-550-B19 shows with photographs and diagrams basic design and practical applications of engine-compressors in refineries, refrigeration plants, sewage works, etc.

12 COMPRESSOR — Bury Compressor Co, Erie, Pa. 16-page bulletin 426 describes construction, features and accessories of steam-driven air compressor, with cross-sectional views and photographs.

13 COMPRESSORS — Pennsylvania Pump & Compressor Co, Easton, Pa. Bulletin No. 192, 24 pages, describes horizontal, duplex, double-acting, water-cooled air or gas compressors for either single or 2-stage compression, with photographs and diagrams. Also outlines new control method.

14 NOZZLES — Spraying Systems Co, Chicago, Ill. Catalog No. 21 describes and illustrates complete line of

G-R-I-P!
Locking Ring



Cut out section showing Locking Ring in place

UNSHAKO
Reg. U. S. Pat. Off.

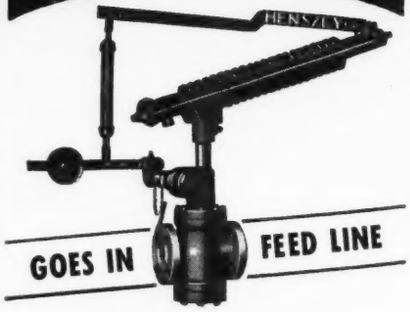
SELF-LOCKING NUT

The built-in, self-energizing locking ring is always on guard and springs to life as soon as any backing off tendency, due to vibration, asserts itself!

"Unshako" therefore is true protection for all moving parts of reciprocating engines, pumps, conveyors, generators, stokers, etc.
For details, write

STANDARD PRESSED STEEL CO.
BOX 577, JENKINTOWN, PENNA.

HENSZEY
BOILER FEED REGULATORS



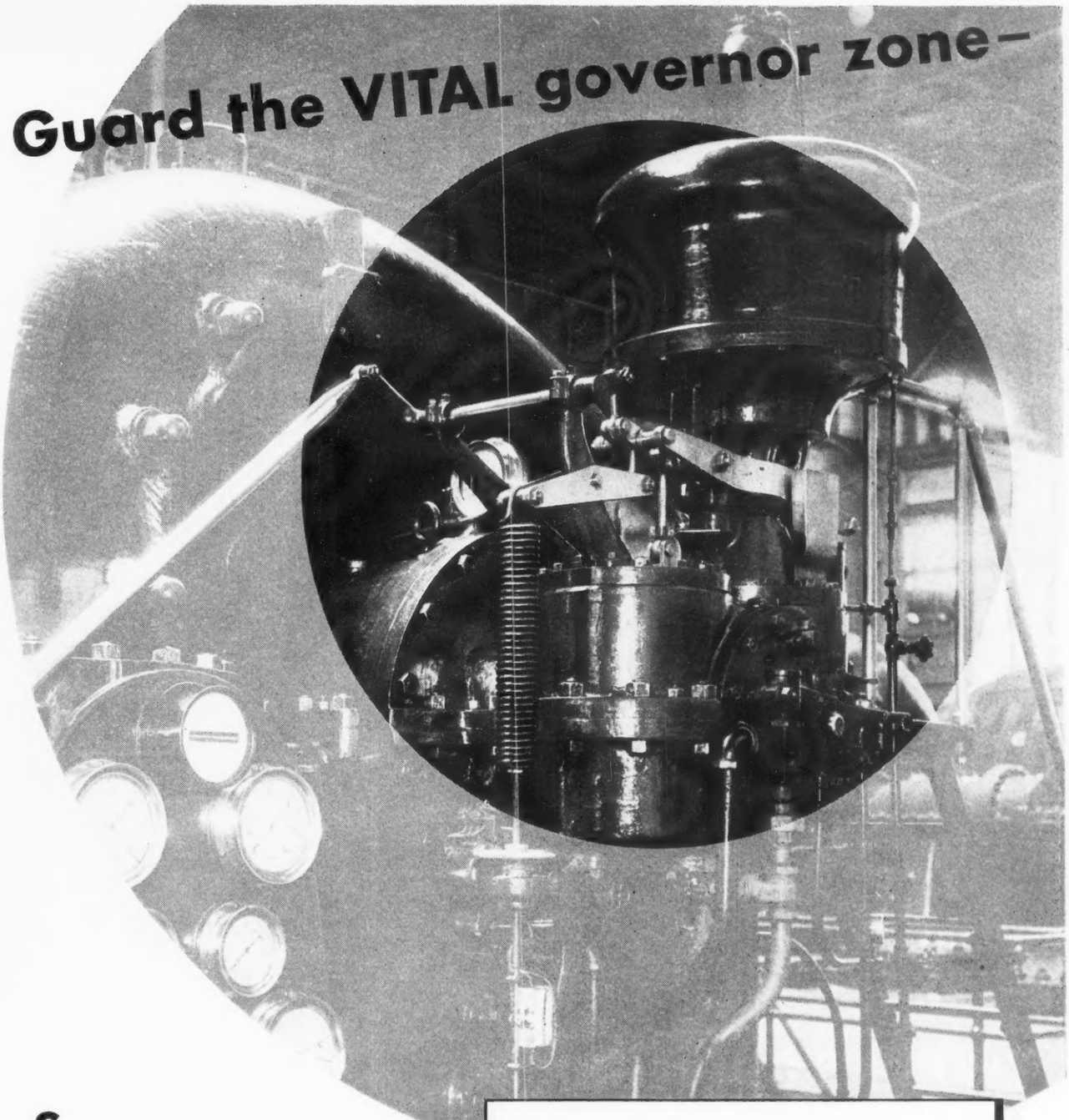
The Henszey Boiler Feed Regulator controls boiler water levels continuously and accurately under *all* load conditions!

These simple, compact, self-contained units go right in the feed line and require no additional structural support. They are as easy to install as a simple gate or globe valve. Once installed and set for operation no further attention is necessary — nothing to get out of order — nothing to reset.

Send for latest Bulletin containing full details.

HENSZEY COMPANY
Dept. D10—Watertown, Wis.

Guard the VITAL governor zone—



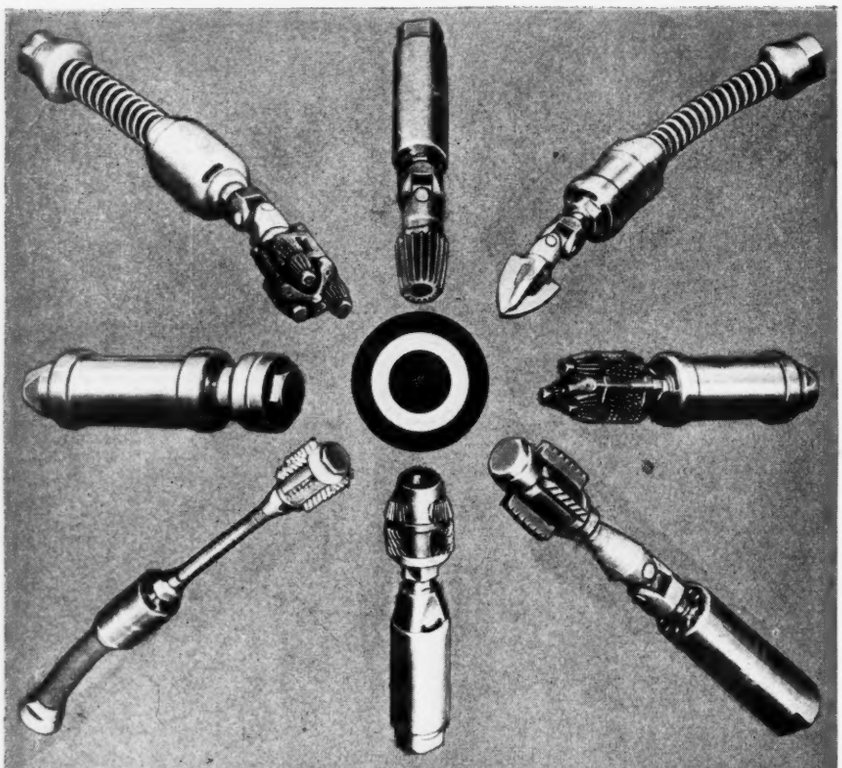
SMALLER CLEARANCES of the governor parts in modern turbines *demand* a turbine oil that will prevent *rust*. And because that same oil must adequately lubricate bearings, gears and flexible couplings to guard against costly shutdowns, it should also have *superior oxidation stability . . . minimum foaming tendencies.* The new Shell Turbo Oil is the first to meet *all* 3 of these requirements.

Call in the Shell man today and let him give you the *facts* about this revolutionary new turbine oil. You'll find his recommendations entirely practical—and made without obligation.

—with the turbine oil that prevents rust

SHELL TURBO OIL

SHELL



TIME SAVED IN CLEANING TUBES SPEEDS UP DEFENSE PRODUCTION

Wilson tube cleaning equipment is playing an important part in our all-out effort for national defense. In hundreds of plants now producing materials or equipment of vital importance to our rearmament program Wilson Tube Cleaners are reducing tube cleaning shut-down time and thus increasing production.

There is a Wilson Tube Cleaner, cutter head, brush, or other accessory to overcome *any* tube fouling scale or sludge *faster, more efficiently,* and *more economically.*

Let us show you how Wilson tube cleaning equipment will reduce tube cleaning time and *increase* production in *your* plant. Write for the name of our representative nearest to you or send for a copy of our thirty-six page catalog fully describing and illustrating the complete line of Wilson tube cleaning equipment.

THOMAS C. WILSON, Inc.

PIPE AND TUBE CLEANERS EXCLUSIVELY

47-28 37th Street — Long Island City, N. Y.

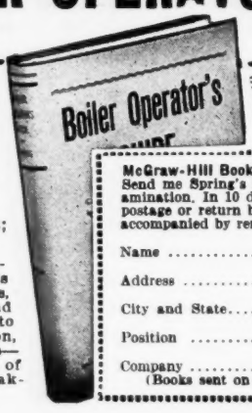
THIS NEW BOILER OPERATOR'S GUIDE

. . . can mean money to you!

JUST OUT! Here's information of the most priceless sort for you — whether you want to improve your ability as an inspector or to utilize effective inspection methods in the more efficient, safer operation and upkeep of your own boilers.

Helps you meet everyday problems; Prepares you for license exams

With hundreds of typical examination questions and answers as well as complete instructions, this book presents fully and plainly the things you want to know about proper installation, operation, and care of boilers—the things that prevent dollars of loss in reduced efficiency, breakdown, or even accident.



By H. M. Spring, Jr.
353 pages, 6 x 9
241 illustrations
$3.00

EXAMINE A COPY FOR 10 DAYS ON APPROVAL

McGraw-Hill Book Co., 330 W. 42nd St., N. Y. C.
Send me Spring's Boiler Operator's Guide for 10 days' examination. In 10 days I will send you $3.00, plus few cents postage or return book postpaid. (We pay postage on orders accompanied by remittance.)

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Address .....

City and State .....

Position .....

Company ..... FP. 9-41

(Books sent on approval in U. S. and Canada only.)

WATER TREATMENT

50 DEAERATORS — Cochrane Corp, Philadelphia, Pa. 36-page catalog includes flow and line diagrams, photographs, etc, showing feature of company's deaerators and accessory equipment. Also explains metering deaerators equipped with V-notch recorders and electrical systems for recording flow from a distance.

50A DESK-TOP TEST—Water Treatment Company of America, 1159 Hodgkiss St, Pittsburgh, Pa. Consists of small bottle of "Baerite" and a rusty screw. Automatic disappearance of rust in two or three days demonstrates one application of "Baerite" water treatment, used for rust, scale, corrosion, foaming, priming and other water difficulties.

50B WATER TREATMENT—National Technical Laboratories, South Pasadena, Calif. 12-page booklet entitled "What Every Executive Should Know About pH" gives a quick, not-too-technical, picture of what pH is and how it may be used to advantage to lower production costs, improve product quality, reduce corrosion and maintenance.

OTHER EQUIPMENT

52 ALLOYS—Handy & Harman, New York, N. Y. 16-page bulletin No. 12 describes low-temperature brazing with Sil-Fos and Easy-Flo, brazing alloys, in many fields of production including aviation, automotive, marine, electrical, air-conditioning, refrigeration and many others.

52C INSULATION — Union Asbestos and Rubber Co, Cicero, Ill. 4-page leaflet describes Unibestos, insulating material for high-temperature service with emphasis on structural strength of material that can support a large pipe. Also contains data for figuring average insulating-job costs and materials.

53 ALLOYS—Ampco Metal, Inc, Milwaukee, Wis. 16-page booklet contains descriptions of alloys, table of alloys, table of physical properties, range of chemical compositions, illustrations of parts and factory scenes.

54 ALLOYS—International Nickel Co, 40 Wall St, New York, N. Y. 12-page catalog gives characteristics, mechanical properties and application information on Inco Nickel Alloys. Also includes tables of physical constants and available forms.

55 CARBURIZING—Leeds & Northrup Co, Stenton Ave, Philadelphia, Pa. 26-page catalog T-623 takes reader on pictorial tour showing heat-treating process; shows furnaces in action and various types of work being carburized.

56 JACKS—Buda Co, Harvey, Ill. 32-page bulletin, No. 1019 illustrates models and sizes for all lifting jobs and offers information on how to select correct jack to use. Also lists prices for each type.

58 FUNCTIONAL FLOOR DESIGN—Open Steel Flooring Institute, Inc, Dept D, American Bank Bldg, Pittsburgh, Pa. 12-page booklet is handbook for architects and engineers on uses and properties of open-steel grating for floors, stair treads, walkways, ventilators, sidewalk grating and platform construction. Hypothetical layout pictured.

59 DATA SHEETS—Ampco Metal, Inc, Milwaukee, Wis. 56-page book of data sheets covers numerous subjects, including phase-concentration-control, centrifugal castings, machining recommendations, etc.

60 DRAFTING ROOM EQUIPMENT—C F Pease Co, Chicago, Ill. 156-page spiral-bound book illustrates company's complete line of products; includes blueprinting machinery, blueprint paper, Multazo direct-process paper, drafting-room furniture, photographic arc lamps and related equipment.

62 TOOLS—Bonney Forge & Tool Works, Allentown, Pa. Catalog No. 41, 104 pages, describes complete line of tools with illustrations of tools ranging from special cabinets and tool sets to screw drivers and pliers.

63 ENGINEERS SERVICES — E J Cheney & Co, New York, N. Y. 4-page leaflet outlines scope of 20-year-old company's services to industrial, construction and public-service organizations.

HERE'S ALL-PURPOSE PRINT MAKING IN ONE COMPACT UNIT

BASIC FACTS ABOUT PRINT MAKING YOU SHOULD KNOW

AN OZALID TRANSPARENT DUPLICATE CAN BE CHANGED AND CORRECTIONS ADDED TO THE SAME PRINT IN EITHER PENCIL OR INK. Subsequent prints will show all the changes . . . the original remaining intact!

Changes and additions are made quickly on a transparent duplicate either by using Ozalid Corrector Fluid for incidental or scattered changes, or the Ozalid "block-out" method for major corrections. Both eliminate the necessity of complete retracing and provide short cuts in drafting.

The corrected transparent duplicate produces prints at a speed 3 to 5 times faster than is possible with a Van Dyke negative. The prints are permanent . . . free of distortion . . . and the changes true-to-scale.

Ozalid transparent materials include a variety of papers, cloth and foils, any of which may be used as a duplicate original for making subsequent work prints. This enables you to file your valuable originals and keep them safe from wear and tear.

This is the second of a series of facts on modern print making. Watch for Fact No. 3.

FOR A COMPLETE, all-purpose method of making prints—and today the demand is for a service more versatile than blue-printing—the Ozalid Process offers a full line of sensitized materials and Whiteprint machines that combine exposure and dry development in one compact unit.

By using the Ozalid Process, you get—in a matter of seconds—positive-type whiteprints of engineering drawings or anything written, typewritten or drawn on reasonably translucent paper . . . prints that are true-to-scale, durable, and will not wrinkle or curl.

With this all-purpose process you get . . . SUCH STANDARD MATERIALS as papers producing black, blue or maroon lines on a white background . . . transparent materials including transparent papers, cloth and foils . . . SUCH SPECIALTIES as paper laminated on cloth . . . airmail weight paper . . . paper coated on both sides . . . opaque cloth . . . correctors for eradicating line detail . . . SUCH SERVICE as fast—economical—print making.

Ozalid whiteprints are made simply by placing the original on a piece of Ozalid sensitized material and feeding both into the machine. Exposure and dry development are combined in the machine to produce a finished print that is dry, ready for immediate use. Ozalid transparent duplicates are produced the same simple way.

Compare this quick, complete process with the indirect way of making blue prints which requires washing—fixing—drying and trimming. Eliminate unnecessary production tie-ups by installing an Ozalid machine. Write for illustrated literature today.

SPECIFY Ozalid WHITEPRINTS

★ **See the OZALID EXHIBIT at the METAL SHOW in PHILADELPHIA . . . BOOTH H-26**

OZALID PRODUCTS DIVISION
GENERAL ANILINE & FILM CORPORATION
JOHNSON CITY, N.Y.
Ozalid in Canada • HUGHES OWEN CO. LTD., Montreal

When you take a chance on untreated or improperly treated boiler feed water, you're risking more than costly repairs. You're taking a chance on a power shut down that might add weeks to your production schedules.

That's why so many plant engineers are turning to FERRISUL (anhydrous ferric sulfate).

Proper treatment with FERRISUL is one sure, safe, and easy way to rid your boiler feed water of silica and organic substances *without* danger of leaving scale-forming or corrosive residuals. Ferrisul's floc is highly adsorptive, forms immediately, settles rapidly, is stable over the entire pH range above 3.5, leaves no harmful coagulant residuals!

Dry and free flowing, Ferrisul is easy to handle... requires no expensive storage tanks ...and can be transferred on any standard conveyor system and introduced into the treatment in standard dry feed machines or in solution feeders. Write for booklet which gives complete technical details. MONSANTO CHEMICAL COMPANY, Merrimac Division, Everett Station, Boston, Massachusetts.

FOR EXPERIENCED TECHNICAL SERVICE

.. Refer your water treating problems to Monsanto's technical department. Monsanto manufactures a full line of water-treating chemicals, is in a position to give sound, unbiased advice on your particular needs.

FERRISUL (anhydrous ferric sulfate)—an effective coagulant for treatment of boiler feed water, sewage, industrial waste, municipal water supply.

SANTOBRITE (sodium pentachlorophenate)—a sure and inexpensive algaecide and fungicide for the control of slime and algae in cooling water systems.

SANTOSITE (sodium sulfite anhydrous technical) a reducing agent for removing oxygen from boiler feed water

MONSANTO CHEMICALS
SERVING INDUSTRY ... WHICH SERVES MANKIND

A Hitch in the Bend

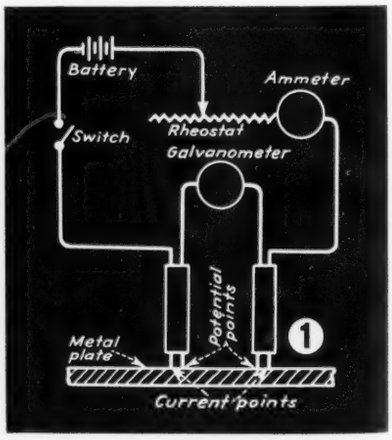
On page 111 of August POWER, the Carrick Bend was shown thus:

An eagle-eyed reader, E H Cummings of Cleveland Heights, Ohio, reminds us in a four-line illustrated letter, that the bight of the right-hand rope at the left side of the knot should pass *under* the short end of the other rope and *over* the main part of it, thus (with due credit to the Boy Scouts of America):

From a secure position behind the "eight ball", the editors compliment Mr Cummings on his powers of observation and rest on Mr Rossnagel's statement that the drawing we copied faithfully has been in use about six years without detection of the error. Within three days of publication in POWER it is all over but the apologies.

More About Metal-Wall Thickness

I read with interest the article by H M Spring in March POWER describing a method of determining metal thickness in pressure vessels by the use of telltale holes. This method is direct and reliable, is a great improvement over the old hammer test and can be applied to advantage in many places. There are, however, many vessels in the chemical industry where the escape of a small quantity of the contents into



Experience of Years

STORED UP

in Helpful Literature...

The pressing demands of the defense program call for the employment of every skill and facility at the disposal of the metal working industries.

Among the resources available is the experience of our technical staff in the solution of problems involving the use of Nickel and its alloys.

This experience has been distilled into helpful literature which deals with the selection, fabrication and uses of these materials. This printed matter is yours for the asking. You are also offered the assistance of our technical staff in solving problems of material arising from the temporary lack of Nickel.

Your inquiries addressed to the Company either for literature or personal consultation will receive prompt attention.

Nickel

THE INTERNATIONAL NICKEL COMPANY, INC. **67 WALL STREET NEW YORK, N. Y.**

FYR-FEEDER is the Modern Spreader Stoker

Sectional view of 6-burner FYR-FEEDER Spreader Stoker.

The Stoker with FEATURES which Engineers WANT and DEMAND!

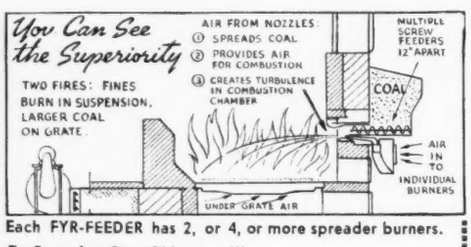
1. **FYR-FEEDER SPREADER STOKER'S ADVANCED DESIGN** makes it the MODERN Spreader Stoker. Developed and engineered to fire boilers rated from 50 h.p. up, with maximum efficiency. Only 2" air pressure used by air nozzles for spreading coal over average size grates.

2. **FYR-FEEDER SPREADER STOKERS BURN CHEAPEST COAL,** wet or dry. Users report saving up to as much as $4.00 per ton by using local screenings, yard sweepings, etc. FYR-FEEDER handles fluctuating loads with ease.

3. **FYR-FEEDER SPREADER STOKER PRODUCES EXCELLENT COMBUSTION,** due, in part, to its perfect coal distribution over grates. Fines burn in suspension—larger coal on grate. Air from nozzle under each feeder (1) spreads coal, (2) provides the necessary overfire air required for completion of combustion and (3) creates turbulence in furnace. FYR-FEEDERS always have 2, 4, or more, feeders.

4. **FYR-FEEDER SPREADER STOKERS ARE OPERATED WITH A THIN FUEL BED.** FYR-FEEDER firing never requires a thick fuel bed or a large mass of coal in the furnace. Therefore, fuel is not wasted when load drops off. In cleaning, fire is allowed to burn out completely on one side of the grate while firing continues uninterruptedly on the other side. For complete information, use coupon below.

Fyr-Feeder
MULTI-BURNER STOKERS


You Can See the Superiority
AIR FROM NOZZLES
① SPREADS COAL
② PROVIDES AIR FOR COMBUSTION
③ CREATES TURBULENCE IN COMBUSTION CHAMBER
TWO FIRES: FINES BURN IN SUSPENSION, LARGER COAL ON GRATE
MULTIPLE SCREW FEEDERS 12" APART
COAL
AIR IN TO INDIVIDUAL BURNERS
UNDER GRATE AIR
Each FYR-FEEDER has 2, or 4, or more spreader burners.

AMERICAN COAL BURNER CO., 151 E. Superior St., Chicago, Ill.
I am interested in your FYR-FEEDER Spreader Stoker because I think it is the best stoker built.
I WANT TO —
☐ Buy them
☐ Sell them
☐ Install them
☐ See an installation
☐ Look over literature

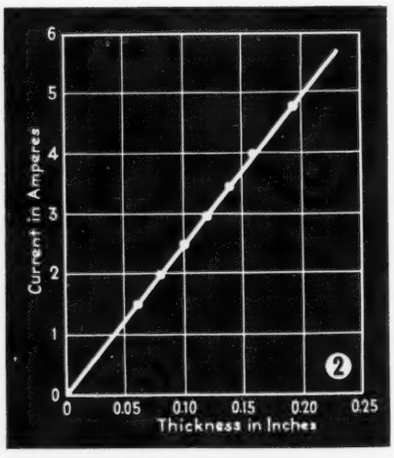
Name .....
Company .....
Address .....

the atmosphere would be dangerous to the operators.

In Great Britain a method has been developed that permits determining the thickness of metal walls from one side, and at any time, without drilling. It was described in a paper before the Institution of Mechanical Engineers, England, in 1938. While primarily designed for testing the thickness of boiler tubes it has been used in oil refineries, chemical works, foundries and aircraft factories.

Metal-Wall Test

The method essentially compares electrical resistance of a metal wall under test with that of a similar shaped metal of the same material, but of known thickness. Fig. 1 is a diagram of an instrument used in this work. Current, usually less than 100 amp, is supplied by a 6- or 12-volt battery to two current contacts held against the Current, usually less than 10 amp, is adjusted by rheostat, by changing the number of battery cells or by both, until the small potential drop indicated by the galvanometer reaches a predetermined value. From a calibration



curve like Fig. 2, which is for a mild steel tube, thickness of the metal can be determined.

A template is used to insure equal spacing of contacts on the metal surface, center punch marks being made through holes in the template. Resistance of the current contact with the metal is immaterial, because the current is adjusted to give a predetermined potential drop. Potential-contact resistance is also not important in practice because the internal resistance of the galvanometer, 35 ohms or more, is very large compared with any variation in contact resistance that is likely to be experienced with intelligent use of the instrument.

Hartford, England B M THORNTON

ROEBLING

"Bridges a Century with Wire"

ROEBLING WIRE ROPE AND STRAND • WIRE ROPE SLINGS AND FITTINGS • SUSPENSION BRIDGES AND CABLES • AERIAL WIRE ROPE SYSTEMS • ELECTRICAL WIRES AND CABLES • HIGH AND LOW CARBON COLD ROLLED STRIP • ROUND AND SHAPED WIRE WIRE CLOTH AND NETTING • STEEL AND COPPER RODS • HIGH AND LOW CARBON ACID AND BASIC OPEN-HEARTH STEELS

100 years ago John A. Roebling founded the company which still bears his name. » » Today, after a century of service, the name Roebling is still synonymous with leadership in wire manufacture, improvement and application.

» » In celebrating its 100th Anniversary, Roebling looks forward to the opportunity of serving industry in even greater measure than ever before.

JOHN A. ROEBLING'S SONS COMPANY

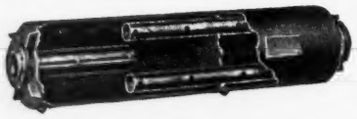
TRENTON, NEW JERSEY

No industrial area is as quiet as this mountain lake 24 hours a day, but even in busy cities the early morning hours find outside noise level at an extremely low point.

That is why more and more plants, operating night and day, are installing Maxim Silencers to quiet engine exhaust or steam blow-off.

The Light & Power Plant at La Junta, Colorado, Maxim equipped, operates 24 hours a day without disturbing nearby residents, some of whom live within 36 feet of the plant.

MAXIM
SILENCERS



ARE WORTH INVESTIGATING

THE MAXIM SILENCER COMPANY
92 Homestead Ave., Hartford, Conn.

Please send details on your silencers for EXHAUST
☐ Internal Combustion engine ☐ steam engine
☐ COMPRESSOR INTAKE ☐ STEAM BLOW-OFF

Name .....

Company .....

Address .....

City..... State.....

John J Nesbitt Dies

John J. Nesbitt, 74, pioneer in the heating and ventilating of school buildings, and a widely recognized authority in the field of heating, piping, ventilating and air conditioning, died September 11, 1941.

Mr Nesbitt was president of John J Nesbitt, Inc, State Road and Rhawn Street, Holmesburg, and lived at Rockfield Farm, Tennis Ave and Welsh Road, Ambler, Pa.

Born in Dublin, Ireland, Mr Nesbitt came to this country at the age of 15, and became a citizen upon reaching his majority.

He devoted his entire business career to the field of heating, piping, ventilating and air conditioning, and in 1917 invented a schoolroom unit ventilator which met with wide acceptance.

In 1938 he was elected a life member in the American Society of Heating and Ventilating Engineers, to which he had belonged for 17 years.

✦

AUSTIN W CLARK has been elected vice-president of National Supply Co, effective April 22. Previous to joining the company as assistant vice president in August, 1940, Mr. Clark was associated with Sears, Roebuck and Co, Chicago.

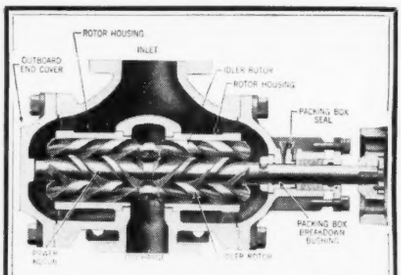
GEORGE W LAND has been named a research engineer on the technical staff of Battelle Memorial Institute, Columbus, Ohio. He is studying methods of treating coal to make it dustless, and will also be assigned to other investigations in the Fuels Research Div.

✦

Simplified Practice for Copper Conductors

Simplified practice recommendation for copper conductors for building purposes, recently proposed as a means of facilitating the national defense program by conserving copper, has been accorded the required degree of acceptance by those interested, and has been approved for promulgation as of July 1, 1941, according to an announcement by the U. S. National Bureau of Standards. This recommendation, to be known as R180-41, lists 17 stock sizes of copper conductors from No. 14 to 500,000 cm, as in the table. It is recommended that sizes larger than 500,000 cm be not carried in stock, but available on order.

The purpose of the recommendation is to focus production, distribution, and use on the recommended sizes, and thus eliminate unnecessary inventories of



ESSENTIALS

The De Laval-IMO Oil Pump

1—*runs* at motor or turbine speeds,
2—*delivers* any oil in any volume against any pressure,
3—*occupies* small space, and
4—*uses* power efficiently.

But DOES NOT

a — have valves, gears, separate bearings or oscillating parts,
b — set up pulsation or vibration,
c — have high-pressure packing boxes, or
d — require disconnection of piping or disturbance of motor for internal inspection.

Ask for Catalog I-84.

IMO
I MOVE OIL

IMO PUMP DIVISION
of the
DeLaval Steam Turbine Co.
Trenton, New Jersey

INCREASE BOILER LIFE
with Modern TAYLOR
pH & Phosphate Control

Taylor Boiler Water Slide Comparator

To control pH and phosphate in water in steam generating equipment and increase boiler life we offer two types of Boiler Water Slide Comparators: Model W, for control of both pH and Phosphates, and Model P for phosphates only, 5 to 100 or 0 to 25 p.p.m. *Write today for our descriptive folder.*

W. A. TAYLOR & CO.
7300 YORK ROAD, BALTIMORE, MD.
Specialists in pH Control Equipment

Insulation Facts · Number 5.

Wetting, or even total submersion for long periods of time, will not alter the original physical form or insulating characteristics of Ehret's 85% Magnesia. Steam and water, ever-present hazards of the boiler room and steam lines, can not cause this material to crumble, loosen, delaminate or stick to the surfaces on which it is applied.

85% Magnesia is but one of a full line of Ehret industrial insulations. There is an Ehret Distributor or Contractor in every principal city.

EHRET MAGNESIA MANUFACTURING CO.

VALLEY FORGE · PENNSYLVANIA

SAVE HEAT WITH · EHRET INSULATIONS

MAKERS OF INDUSTRIAL INSULATIONS FOR MORE THAN 40 YEARS

Clean Evaporator Coils This Easy, Time-Saving Way!

Do you want an easier, faster way to remove lime-scale and oxidized deposits from your evaporator coils? Then investigate Oakite Compound No. 32, a material specially designed to HELP YOU solve this and related maintenance problems economically!

Due to its controlled scale-dissolving action, this remarkable material is far SAFER than commercial acids. Does its work thoroughly, quickly . . . without harming metal surfaces. Easy to use, too. Just circulate recommended solution through system as directed.

NEW BOOKLET FREE!

The revised third edition of this 20-page booklet gives further details . . . concisely describes safe, successful, low-cost methods for de-scaling and cleaning Diesel water jackets, "lube" oil and jacket water coolers, surface condensers, feedwater heaters. YOUR copy is FREE! Write for it today!

OAKITE PRODUCTS, INC.
23 Thames Street, New York, N. Y.
Representatives in All Principal Cities of the United States and Canada.

OAKITE *Certified cleaning*
MATERIALS & METHODS FOR EVERY CLEANING REQUIREMENT

copper wire. According to the National Electrical Contractors Association, which sponsored the program, appreciable copper tonnages are now tied up in inventories of slow moving sizes, mostly in the upper size range. These can be more efficiently taken care of from an electrical standpoint, by smaller cables connected in multiple. The cooperation of all interests in conforming their requirements to the recommended sizes of copper conductors will facilitate more efficient production, distribution and use of this product, and will release for more productive uses copper that would otherwise be tied up in inventories of slow moving seldom called for sizes. Everyone who is in any way concerned with the production, distribution, or use of copper conductors is urged to adhere to the recommendation. Copies of these recommendations may be obtained without charge from the Division of Simplified Practice, National Bureau of Standards, Washington, D. C.

Recommended Wire Sizes

Size AWG	Size AWG	Size CM
14	2	250,000
12	1	300,000
10	0	350,000
8	00	400,000
6	000	500,000
4	0000	

G E to Build Generators For Kentucky Dam

Contracts for five more waterwheel generators to keep pace with the rapidly increasing power demand of defense manufacturing in the area it serves have been awarded by the Tennessee Valley Authority to the General Electric Co.

The five generators ordered are for the Kentucky Dam and power site located on the Tennessee River in Marshall and Livingston counties, about 26 miles from Paducah, Kentucky.

The generators will be built at General Electric's Schenectady Works. Each will be rated 32,000 kw, operating at 78.3 rpm. It is expected that the first of the five units will be installed and ready for operation in the latter part of 1943. The fifth will be installed and ready for operation by the middle of 1944.

Shipments of three 30,000-kilowatt generators for another TVA project, the Cherokee dam and power plant on the Holston River near Jefferson City,

HERCULES
Seamless Copper
FLOATS

GUARANTEED TO STAND UP!

Every Hercules Float carries our guarantee to stand up under 350 lbs. working pressure and 500 degrees temperature.

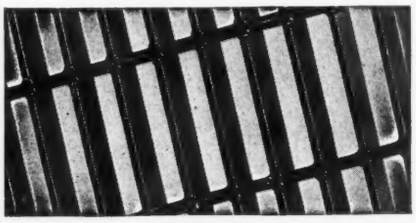
Fabricated of seamless copper under our special spinning process. Hercules Floats are uniform in thickness and high in mechanical strength.

You can depend on Hercules for floats—in standard shapes up to 10 in. and in special types to your specifications—to give long, dependable, economical service.

Insure care-free maintenance of water level in your heaters, tanks, reservoirs and other equipment by specifying "HERCULES."

HERCULES FLOAT WORKS
200 Franklin St.
SPRINGFIELD, MASS.

BATESGRATES
FILLET WELD
Open Steel Floor Grating



Easily maintained - - -
NO CRACKS, JOINTS, CREVICES

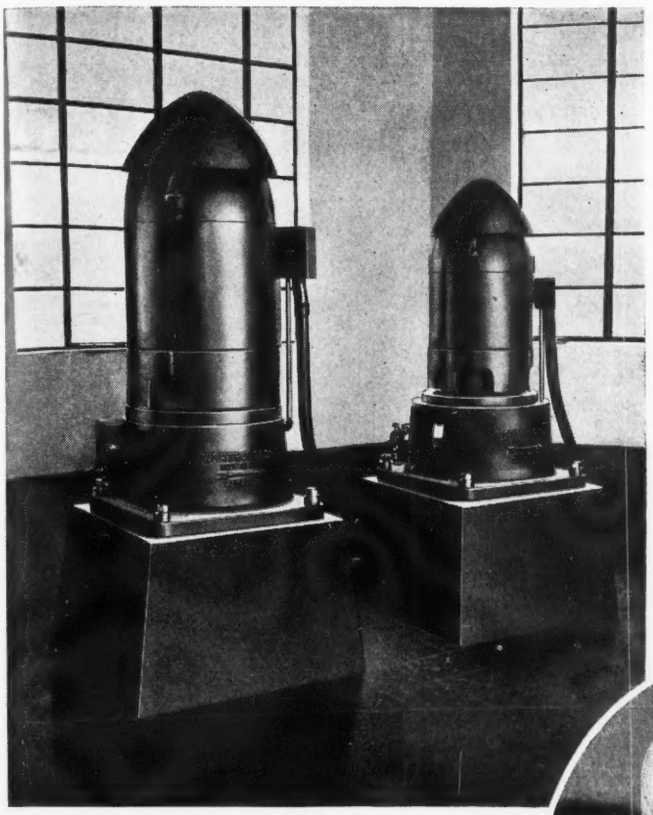
Batesgrates are self-cleaning because of peaked, non-skid cross bar. They have no grooves or rough burned metal to catch grease or dirt. Safe traction. Batesgrates are strictly one piece—no cuts, slots, or punching. Made from Hexagon Shaped Hot Rolled Steel Bars with smoother, larger, much stronger welds. Send today for engineering Catalog No. 937.

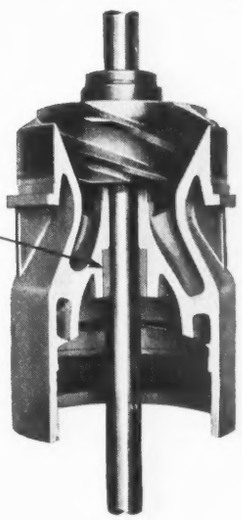
When you need grates
SPECIFY BATES
for long-time economy

WALTER BATES CO.
208 S. LaSalle St. Chicago, Ill.

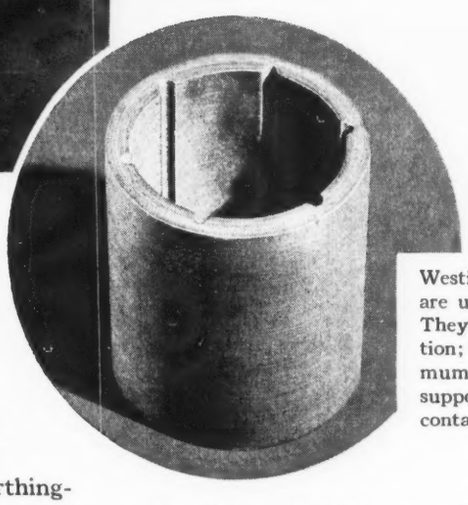
Worthington Pump finds Westinghouse Micarta makes

BETTER BUSHINGS





Micarta bushings give strong support but are soft enough so grit does not score pump shaft.



Westinghouse Micarta bushings are used on Worthington pumps. They require only water lubrication; reduce shaft wear to a minimum yet provide firm shaft support; are unharmed by water containing oil, acids or alkalies.

Micarta bushings improve performance of turbine well pumps

As a result of a study to determine what type of impeller shaft bushing would best meet different operating conditions, Worthington Pump and Machinery Corporation selected Westinghouse Micarta.

Micarta bushings are used on Worthington turbine pumps because they combine the advantages of the several different types of bushings previously used. They are hard enough to provide a firm support for the impeller shaft, yet soft enough so that grit and metallic particles become imbedded without scoring the shaft. They require only water lubrication and, because of their low coefficient of friction, are not harmed by starting the pump with the water below bushing level. They are not subject to galvanic action and are unaffected by oil or mild chemicals which might be present in the water. They are fluted to wash out sand and grit.

With the advantages of Micarta bushings added to the quality features of Worthington pumps, users can expect outstanding service and lower maintenance. For full information about other uses for Micarta, call our nearest office. Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

J-94458

Westinghouse *Micarta*

The men here at Viking are a pretty peace-loving lot. They work hard, like to picnic, to boat and fish on the river, to go for long drives with their families. But let a national emergency pop-up, like the one we've got now, and they can get tough in a hurry.

We've watched our men bend a little closer to their lathes, we've seen them sacrifice leisure time for overtime, we've caught the seriousness of their attack upon a casting, an assembly job, a shipping crate. They know that in their efforts is America's answer.

In comparison with the big, sprawling airplane factories and booming steel mills, our job seems sorta small and insignificant. But to all of us here at Viking it's the most important thing we've ever done.

VIKING
PUMP COMPANY
CEDAR FALLS, IOWA

Tennessee, are scheduled to begin soon from General Electric's Schenectady Works.

Three 60,000-kw steam turbine-generators are also being manufactured by General Electric for TVA's Watts Bar power plant near Chattanooga. Shipment of the first of these units is expected in October, and installation of the second and third units will be completed by the end of 1942, and early in 1943 respectively.

Harold Stein Passes

Harold J Stein, 47, director of research, chemistry and metallurgy at the Allis-Chalmers Mfg Company, died September 9. Mr Stein directed these activities since 1939, when they were consolidated into one department upon the retirement of R S MacPherran, chief chemist.

Mr Stein came to Allis-Chalmers as a student apprentice in 1916, served in various manufacturing departments and was in turn made general foreman of the company's heat treating operations, assistant foreman of the forge department and later a research engineer. In 1936 he was made chief research engineer of all the manufacturing departments of Allis-Chalmers.

Mr Stein was born in Philadelphia, Pa., the son of Joseph Stein, superintendent of the experimental station at the naval academy, Annapolis. He attended Tri-State college at Angola, Ind. For many years he had been a member of the American Society of Testing Materials, the American Foundrymen's Association and the American Society of Metals, the Milwaukee chapter of which he was instrumental in founding.

✦

Harlow Bradley, for many years connected with the Allis-Chalmers Mfg Co, has been appointed supervisor of foreign dealers for the company. In his new capacity his chief duties will be to promote sale of industrial machinery in foreign countries. His headquarters will be in Milwaukee.

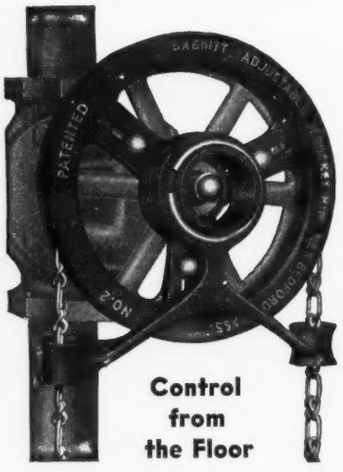
Roy S Laird has been appointed sales manager for Ohmite Mfg Co, Chicago. He has been with the company 5 years as sales engineer, and is an Electrical Engineering graduate of the University of Illinois.

✦

Monsanto Builds

Monsanto Chemical Company will build a 2-story steam power plant, 40x 70 feet, to cost about $75,000 with equipment.

Make Your Overhead Valves SAFE And Easy to Reach---



Control from the Floor

With the Babbitt Rim for Valves you eliminate danger and banish the step-ladder. You can now place your valves wherever they come economically and conveniently. They fit any valve. Let us tell you more about them. Write today.

BABBITT STEAM SPECIALTY CO.
New Bedford, Mass.

Flanged Slide Type

IT'S like putting money in the bank to replace old style blast gates—the kind that leak, waste power, and "make up" a wobbly line—with Rockwell Blast Gates. These gates have many features that make them the outstanding "buy" in all branches of industry.

Write for Catalog No. 4020

W. S. ROCKWELL COMPANY
Blast Gate Division
50 CHURCH STREET NEW YORK, N. Y.

You can always get what the job calls for in the WeldELL *line!*

The widest selection of types–sizes–thicknesses

ONE of the major advantages in using Taylor Forge WeldELLS and other Taylor Forge Welding Fittings is that in this one broad line is included practically every type, size, thickness and material that is ever required on any pipe welding job.

Naturally not all of the many types of Taylor Forge Welding Fittings are as widely used as WeldELLS. There are bound to be some "slow movers" in such a big line, and the small demand for such fittings, with no corresponding reduction in tooling and other production costs, sometimes makes them unprofitable to us.

But we couldn't follow our basic business principle of providing *maximum utility, convenience and economy,* and be satisfied with a "short line" The needs of our customers are too important to us. That's why you'll find Taylor Forge making a more complete line of Welding Fittings than any other manufacturer.

Just another example of the extra value Taylor Forge provides at no extra cost to the user . . . for WeldELLS and other Taylor Forge Fittings for Pipe Welding cost no more than other makes.

• To learn just how complete the Taylor Forge line really is get Catalog 401. There's a lot of other useful information in this book, too. Write for your copy today.

OTHER EXTRA VALUE FEATURES

In addition to the features described opposite, WeldELLS have the following advantages which are combined in no other welding fitting:

1. Seamless—greater strength and uniformity.

2. Tangents—keep weld away from zone of highest stress—simplify lining up.

3. Precision quarter-marked ends—simplify layout and help insure accuracy.

4. Permanent and complete identification marking*—saves time and eliminates errors in shop and field.

5. Selective reinforcement—provides uniform strength.

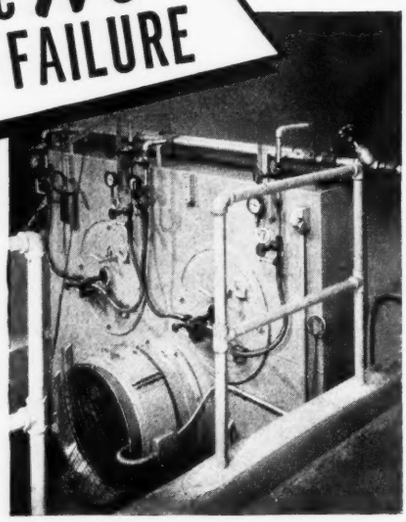
6. Wall Thickness never less than specification minimum—assures full strength and long life.

7. Machine tool beveled ends—provides best welding surface and accurate bevel and land.

*Since the marking is pressed into the metal before forming, and since the manufacture of the fittings is carried out at a forging temperature, each in effect receives a heat treatment after the operation. The indentations have no sharp corners or edges and the marking has no effect on the strength of the fitting.

TAYLOR FORGE & PIPE WORKS, General Offices & Works: Chicago. P. O. Box 485
New York Office: 50 Church Street • Philadelphia Office: Broad Street Station Bldg.

...There must be NO MECHANICAL FAILURE



PRESENT demands require, more than ever, that a boiler STAY "on the line" for long, uninterrupted periods. Where oil fuel is used, this calls for absolute dependability on the part of the oil burning equipment . . . there must be no mechanical failure.

The success of Enco Oil Burning installations lies in the proper coordination of the many details involved—efficient burners properly selected and applied—dependable Oil Pumping and Heating Equipment provided with all automatic controls for delivering the fuel oil at the correct temperature and pressure, together with all safety devices against improper operation.

We will be glad to send you Bulletins OB-40 and 37 describing ENCO Oil Burning, Pumping and Heating Equipment.

THE ENGINEER COMPANY
75 WEST STREET (Enco) NEW YORK, N. Y.

KEWANEE FIREBOX BOILERS

Extra Strength....for Heavy Duty

Wherever heavy duty demands extra strength . . . Kewanee Steel riveted boilers are preferred. For the known strength assured by **Steel + Rivets,** supplemented by extra stout stays and braces in the boiler shell, mean many added years of service.

Ask our nearest office or write for Cat. 96 K-X

KEWANEE BOILER CORPORATION Kewanee, Illinois
division.
American Radiator and Standard Sanitary Corporation

They *WEAR* themselves into perfect condition

Tests prove that Sea-Ro Graphitized Rings acquire a hard glass-like surface after long operation, and being of a floating type, reduce wear on cylinder liners.

Sea-Ro No. 528 Rings are recommended for plungers of pumps handling hot or cold water, oils, gasoline, solvents, ammonia, etc.

For large heavy-duty pumps, use Sea-Ro No. 525 Rings, with patented internal expansion spring.

SEA-RO GRAPHITIZED
PUMP PLUNGER RINGS No. 528

Send for detailed information.

SEA-RO
SEA-RO PACKING CO., INC., WOOD-RIDGE, N. J.

Special Freight Cars Haul Huge Boilers

Three special-type freight cars were built to haul the three huge boilers from the plant of the American Locomotive Company at Schenectady, N. Y. to the Todd-Bath Iron Shipbuilding Company at South Portland, Me. They will be used in cargo vessels being built there for Great Britain. They were the first of thirty such shipments of 90 boilers which are being manufactured for other cargo vessels in a big contract for the British government.

Loaded on railroad cars the boilers are each 17 ft 7 in. high, 12 ft 6 in. wide, and weigh 102,200 pounds each. They presented a major transportation problem, not because of their weight, but because of their dimensions. Special depressed platform cars had to be built to carry them. The route from Schenectady direct to Portland is 283 miles, but in order to get the boilers to Portland, six railroads had to move the cars 381 miles: gantlet one bridge in New York; move a water column in Vermont; raise tracks over two bridges in Maine and Vermont; shift a track temporarily 80 feet at another Vermont point and widen certain cuts in the White Mountains—before they could be moved as part of regular freight trains.

So close was the clearance at some points that each railroad issued special orders as to tracks to be used, switch lights to be moved, assuring the passing of the train. In crossing a bridge over the Saco river the boilers cleared the superstructure by inches. Veteran traffic men said that it was one of the most ingenious and successfully planned and executed moves in the history of American transportation. And probably the same procedure will have to be gone through thirty more times as the additional boilers are finished.

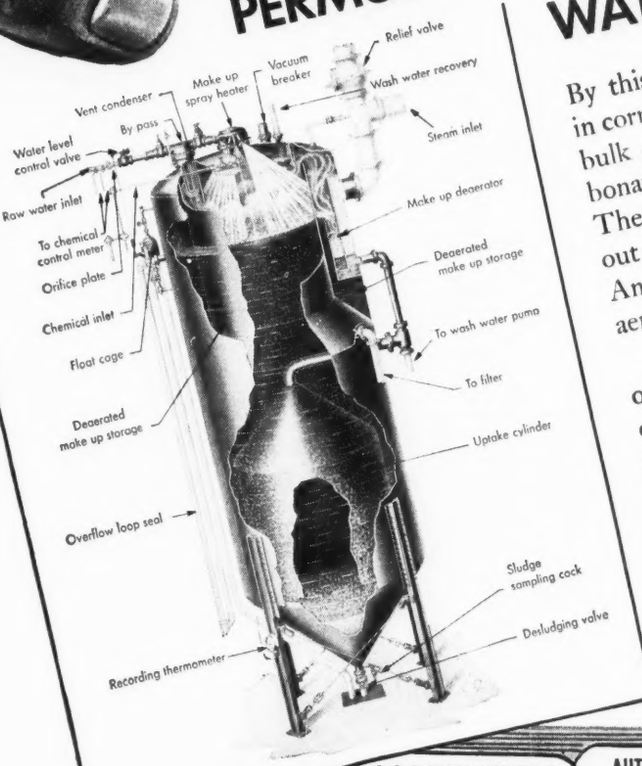
Largest DC Motors Installed In Aluminum Plant

The largest d-c motors ever built for the production of aluminum are now being installed in the huge, 55-acre Alcoa, Tenn., plant of Aluminum Company of America. Each of the two 5,000-horsepower motors built by Westinghouse will drive a 96-in. reversing hot mill that will roll aluminum ingots into slabs.

Aluminum alloy sheet to be produced in the new Alcoa mill will have a tensile strength as great as that of structural steel, yet will be only one-third

HOT PROCESS SOFTENER

PERMUTIT* HOT LIME SODA WATER SOFTENER



By this process, lime and soda ash, in correct proportions, precipitate the bulk of the hardness as calcium carbonate and magnesium hydroxide. The sludge that is formed is settled out and then the water is filtered. An integral heater simultaneously deaerates the water.

Permutit Hot Lime Soda Softeners offer many advantages. Improved chemical feed—fully automatic, insures chemical flow in correct proportion to raw water. New-type valve automatically releases sludge from settling tanks. New pilot-operated hydraulic valve makes backwashing of filter beds positive, completely *automatic*.

REMOVAL of OXYGEN and FREE CO_2

COLD PROCESS SOFTENER | AUTOMATIC ZEOLITE SOFTENER

PERMUTIT

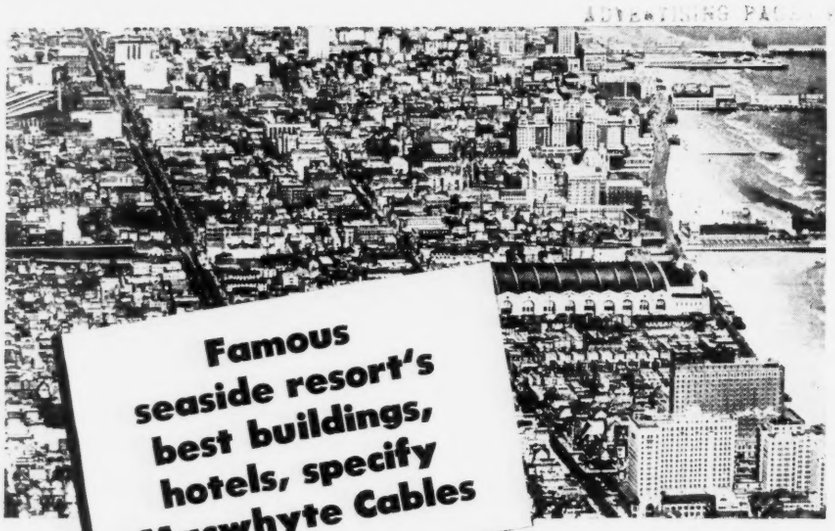
PROVIDES MODERN EQUIPMENT FOR EVERY WATER CONDITIONING PROCESS

You want water treatment that fits your individual plant requirements and raw water supply. Permutit can recommend equipment impartially, because Permutit makes every type—zeolite softeners, silica-removing equipment, deaerating heaters, etc.

Let Permutit work with your engineers or consultants to plan efficient, economical water treatment. Write for free booklet: The Permutit Company, Dept. A, 330 West 42nd Street, New York, N. Y.

*Trademark Reg. U. S. Pat. Off.

WATER CONDITIONING HEADQUARTERS



Famous seaside resort's best buildings, hotels, specify Macwhyte Cables

Atlantic City, N. J. Year after year thousands flock to this renowned resort . . . and are provided with safe vertical transportation. Here in Atlantic City you'll find elevators in the most prominent hotels, stores and buildings equipped with Macwhyte Special Traction Elevator Cables.

Pioneered by Macwhyte

Today more and more building engineers, superintendents, and managers, are using Macwhyte Special Traction, the 8 x 19 construction pioneered by Macwhyte.

And now, "Hi-Speed" PREformed Special Traction 8 x 19 has still greater fatigue resistance and much greater flexibility (which helps reduce sheave wear). And a special Macwhyte lubricant covers every wire to provide continuous protection from corrosion and friction. Next time specify "Hi-Speed" PREformed hoisting cable. You'll like the way it hugs sheaves and drums without slipping.

MACWHYTE COMPANY, 2944 Fourteenth Ave., Kenosha, Wis. • *Manufacturers of wire rope to meet every need—left-&-right lay braided slings—Stainless Steel wire rope—Monel Metal wire rope—Aircraft cable, Aircraft tie-rods, and "Safe-Lock" Swaged Terminals.*

Hi Speed

NO. 577E

MACWHYTE SPECIAL TRACTION

PRE-FORMED FOR Elevator Cable *BEST PERFORMANCE*

CRANE ROPES

Put MONARCH WHYTE STRAND PREformed CRANE ROPES to work—for safety and economy. Ask for details.

TESTED INTERNALLY LUBRICATED PROVED

MACWHYTE COMPANY
2944 Fourteenth Avenue
Kenosha, Wisconsin

SLINGS

Try this new technique of heavy lifting. Your loads will be handled safely and easily. Send for literature on ATLAS Braided Wire Rope Slings.

MACWHYTE Atlas BRAIDED WIRE ROPE Slings

MACWHYTE COMPANY
2944 Fourteenth Avenue
Kenosha, Wisconsin

as heavy. High strength aluminum alloy sheet and other forms of aluminum comprise as much as 90 per cent of the weight of an all-metal airplane.

Built specially for this aluminum mill, the motors weigh 480,000 pounds each and have the greatest horsepower ever built into machines designed to operate at the slow base speed of 30 rpm. Normally, such motors operate at base speeds of 50 to 60 rpm.

Direct current required to operate each unit will be provided by a 4,000-kw motor generator set powered by a 6,500-horsepower synchronous driving motor.

The new Alcoa mill is part of a $200,000,000 expansion program financed and undertaken by Aluminum Company of America to meet national defense aluminum requirements. The expansion program has already doubled the company's 1939 production capacity.

Sabotaged Ships Repaired by Welding

Several sabotaged ships, taken over this spring by the United States Government, and found in a severely damaged condition, were repaired by welding, according to releases from Linde Air Products Co and the Lincoln Electric Co. The ships were the Italian freighters "San Giuseppe", "SS Villaperosa" and "Vittorin". The first and third were repaired by oxyacetylene welding, while the second was repaired by electric-arc welding.

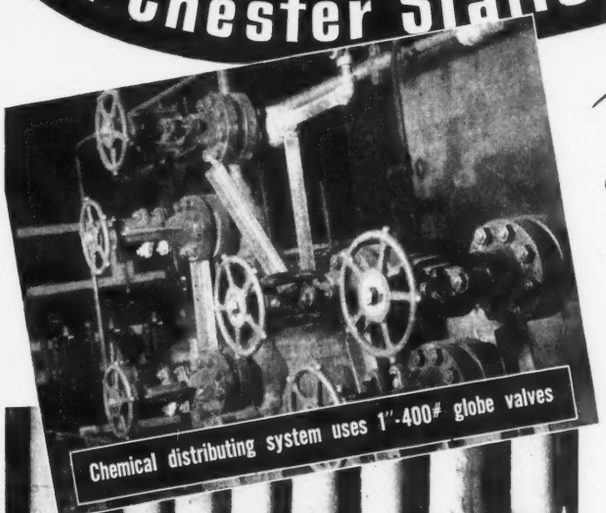
Speed was the feature of the repair of the SS Villaperosa, the damage being fixed in less than 2 months by arc welding. The normal period for replacement was estimated at one year, arc welding saving 10 months. Damage to the engine, consisting of breakage of the bedplate into literally thousands of pieces, resulted when the huge crank arms, turned over by compressed air, jammed against heavy pieces of steel placed by saboteurs on the bedplate under the arms. Arc-welded repair consisted of fusing the many broken pieces of cast iron back together and joining reinforcing steel plates to steel dowel pins inserted in the bedplate. "Ferroweld" and "Stainweld A5" arc welding electrodes, together with 200-amp electric-motor-driven "Shield-Arc" welding machines made by the Lincoln Electric Co were used for the work.

On the other two ships, U-shaped sections had been broken out of the walls in the intermediate pressure cylinders just below the steam ports. After new sections were cast to fit the breaks, they

STEAM VALVES

on Chester Station's New No.5 Unit!

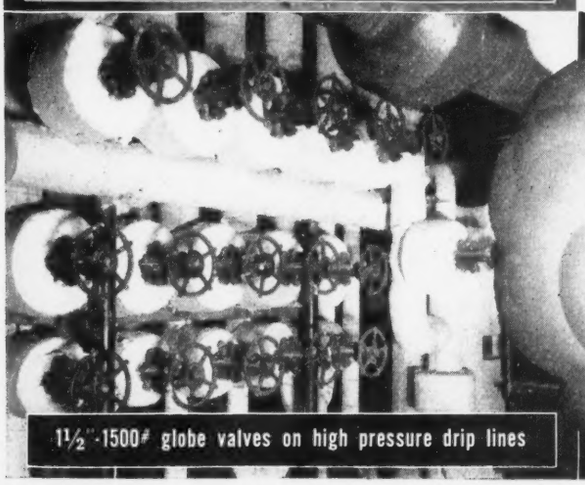
by Vogt



Chemical distributing system uses 1"-400# globe valves

1¼"-600# gate valves on desuperheater manifold

Vogt Steel Valves are d-r-o-p f-o-r-g-e-d and that's why they are extra strong and extra tough . . . operating with a maximum of dependability and a minimum of maintenance in exacting flow control services . . . the kind of performance that is a "must" with power plants like Chester Station of the Philadelphia Electric Company.



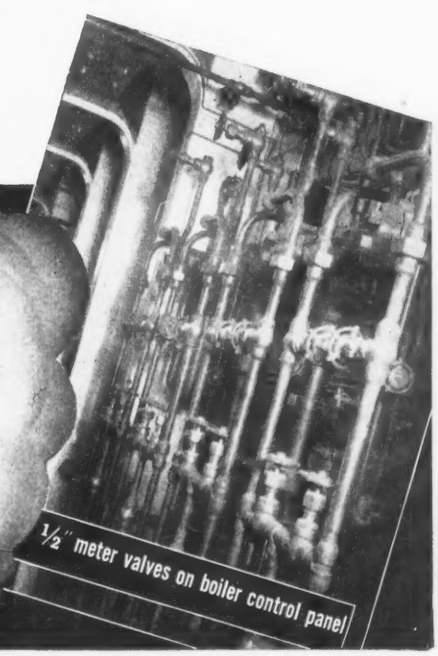
1½"-1500# globe valves on high pressure drip lines

HENRY VOGT MACHINE CO.,

INCORPORATED

LOUISVILLE, KENTUCKY

Branch Offices:
New York, Philadelphia, Cleveland, Chicago, Cincinnati, St. Louis, Dallas



½" meter valves on boiler control panel

Strengthen the joints and you will increase the life of your FURNACE LININGS

HOW? By laying up the brick with Adamant Fire Brick Cement, the cement with the unusually high bonding strength that makes the joints strong as the brick they bond. This is no idle claim, for in impartial laboratory tests made by a leading technical laboratory the average modulus of 5 test joints showed

ADAMANT FIRE BRICK CEMENT

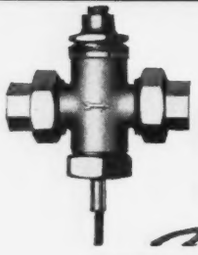
has a BONDING STRENGTH of 800 lbs. per sq. in. at room temperature — 1270 lbs. per sq. in. at 2600° F.

Many plants have found the use of Adamant keeps their furnaces in service longer before relining becomes necessary . . . giving greater production from existing equipment. Let us tell you all the facts . . . write

ADAMANT has a P.C.E. of over 3000° F.

BOTFIELD REFRACTORIES COMPANY

784 S. Swanson St., Philadelphia, Pa.
In Canada, Canadian Botfield Refractories Co., Ltd., 171 Eastern Avenue, Toronto



U. S. NAVY

Served by . . .

STERLING TEMPERATURE CONTROLS

Hundreds of hot water storage tanks in U. S. Navy Barracks from Alaska to the Gulf, from California to Maine, are today kept at constant temperature by STERLING TEMPERATURE CONTROLS . . . At a low cost that saves many Defense dollars. It's the same simple, efficient Temperature Control (No. 150) that is so effectively serving many industries in steam-heated hot water tanks, fuel-oil preheaters, plating baths, heat exchangers and processing plants . . . a quality product of Sterling Engineers.

STERLING, INC.

3713-E N. Holton Street Milwaukee, Wis.

STERLING, INC.

were bronze-welded in place. Starting at the bottom of the U, the operator alternated from one side to the other every three inches, first half-filling the V, peening the deposited metal, then completing the weld and peening. Other parts of the ships on which bronze welding was used to repair included main engine valves, cylinder heads and foundation columns.

Engineers' Books

Thermodynamics

ELEMENTS OF ENGINEERING THERMODYNAMICS (Sixth Edition—1941). *By J A Moyer, J P Calderwood and A A Potter. Published by John Wiley & Sons, 440 Fourth Ave, New York, N. Y. 212 pages, 6x9 in., illustrations and Mollier chart. Price $2.50.*

Up-to-date elementary college text, rewritten to conform to latest practice and containing new material on thermodynamic treatment of uniform flow processes, the revised edition devotes additional space to cycles, heat transfer, refrigeration and air conditioning. New problems, new tables and new illustrations have been added.

Piping and Valves

PIPES AND VALVES (1941) *by a staff of technical experts under the direction of E Molloy. Published by Chemical Publishing Co, 234 King St., Brooklyn, N. Y. 96 pages, 5½x8½ in., 167 illustrations. Price $2.*

A practical little book, profusely illustrated, for pipe erectors. Not only gives information for laying out and installation of bell-and-spigot, cast-iron, wrought-iron and steel piping but contains many brief, to-the-point paragraphs on threading, cutting, bending, gaskets, welding and joining various piping systems. Other chapters cover valves, cocks, fittings and accessories. The book has a distinctly British tinge that interferes in no way with its application to American practice.

CODE FOR MEASUREMENT OF WATER. USING STANDARD ISA ORIFICES WITH FREE DISCHARGE. *Published by Hydraulic Institute, 90 West St, New York. N. Y. 16 pages, 8½x11 in., illustrated.*

"STANDCO" PILLOW BLOCKS

Fig. 1635

Combining clamp block and pillow block requirements in one type, the "Standco" shown above is sturdily built and is offered in a wide range of sizes. Babbitted bearing surfaces are finished beautifully smooth, both faces machined. It can be depended on for long, trouble-free service.

"Standco" Ball and Socket Pillow Block, Ring or Wick Oiling, Plain or Collar End Babbitted Bearings.

Fig. 32

Write for Bulletin

STANDARD PRESSED STEEL CO.

JENKINTOWN, PENNA.

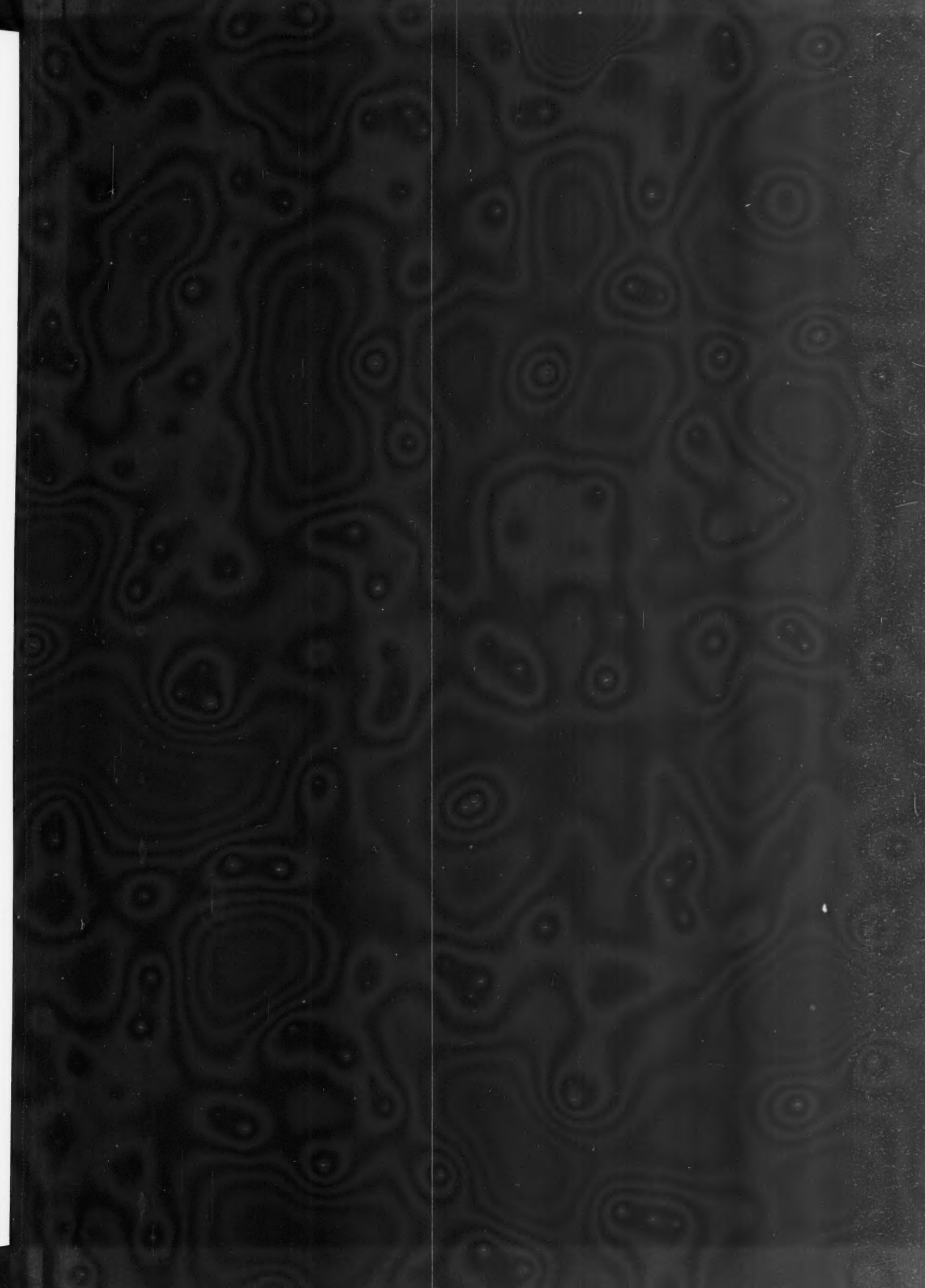
Boston Chicago
Detroit Box 577 St. Louis
Indianapolis San Francisco

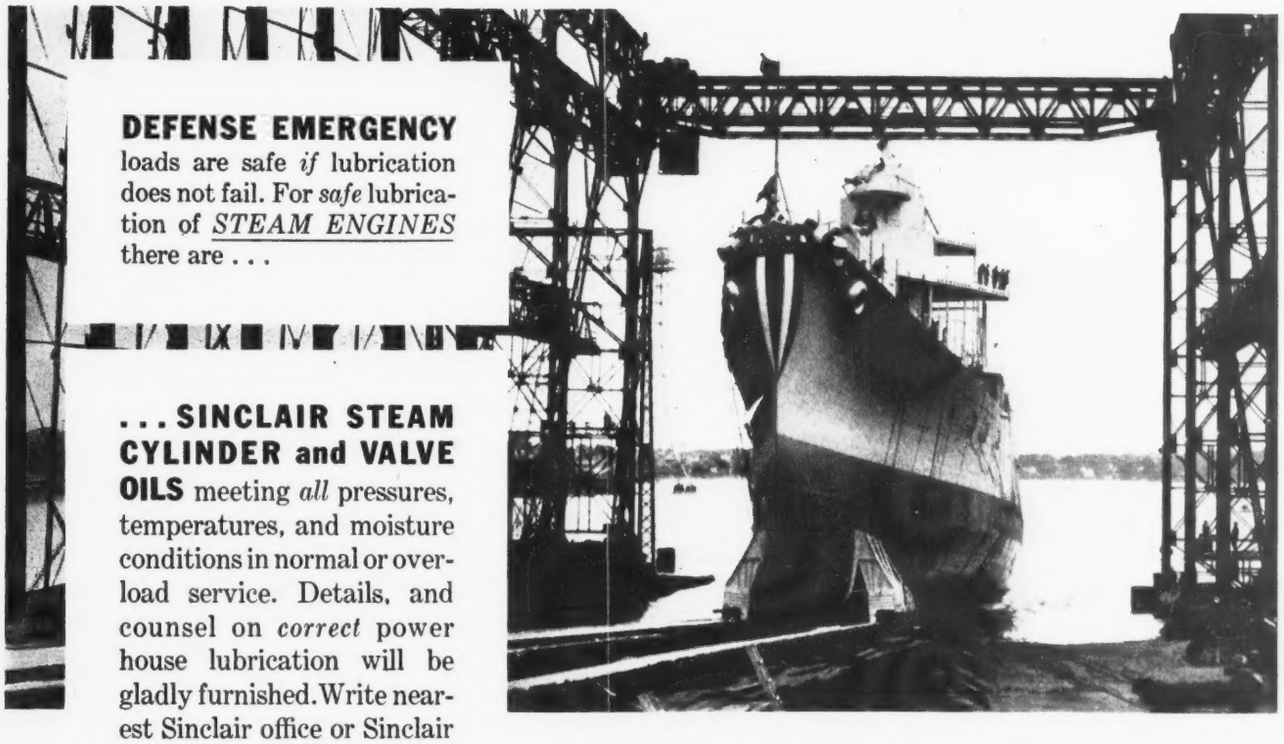
YOUR Dependable Guide

. . . to the big things and little things done each month by operators and manufacturers across the country to raise plant efficiencies, cut costs, and reduce trouble.

It Pays You to

Read POWER Regularly

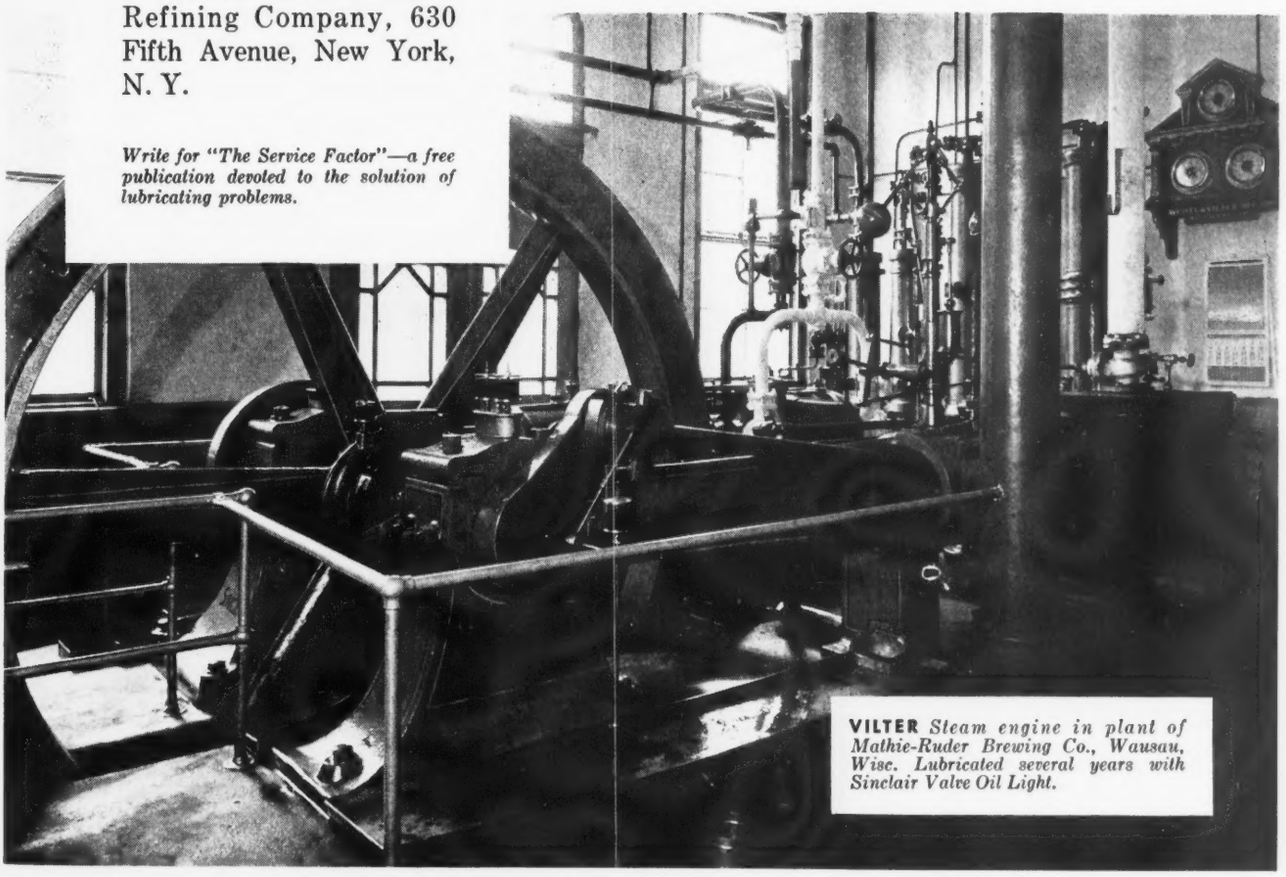




DEFENSE EMERGENCY loads are safe *if* lubrication does not fail. For *safe* lubrication of *STEAM ENGINES* there are . . .

. . . SINCLAIR STEAM CYLINDER and VALVE OILS meeting *all* pressures, temperatures, and moisture conditions in normal or overload service. Details, and counsel on *correct* power house lubrication will be gladly furnished. Write nearest Sinclair office or Sinclair Refining Company, 630 Fifth Avenue, New York, N. Y.

Write for "The Service Factor"—a free publication devoted to the solution of lubricating problems.



VILTER *Steam engine in plant of Mathie-Ruder Brewing Co., Wausau, Wisc. Lubricated several years with Sinclair Valve Oil Light.*

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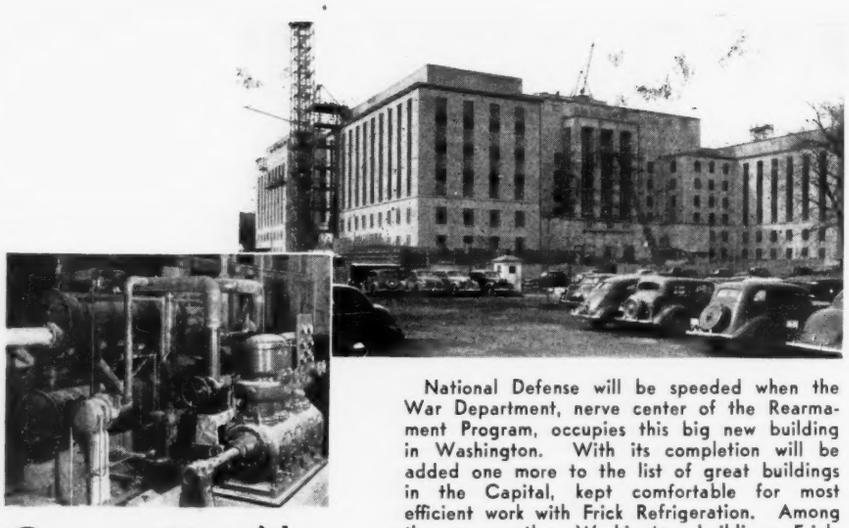

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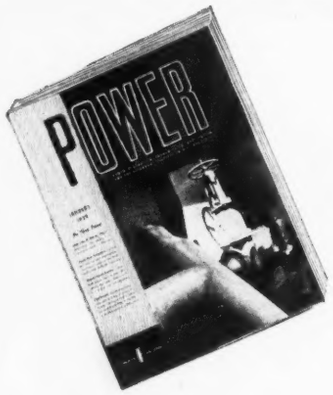

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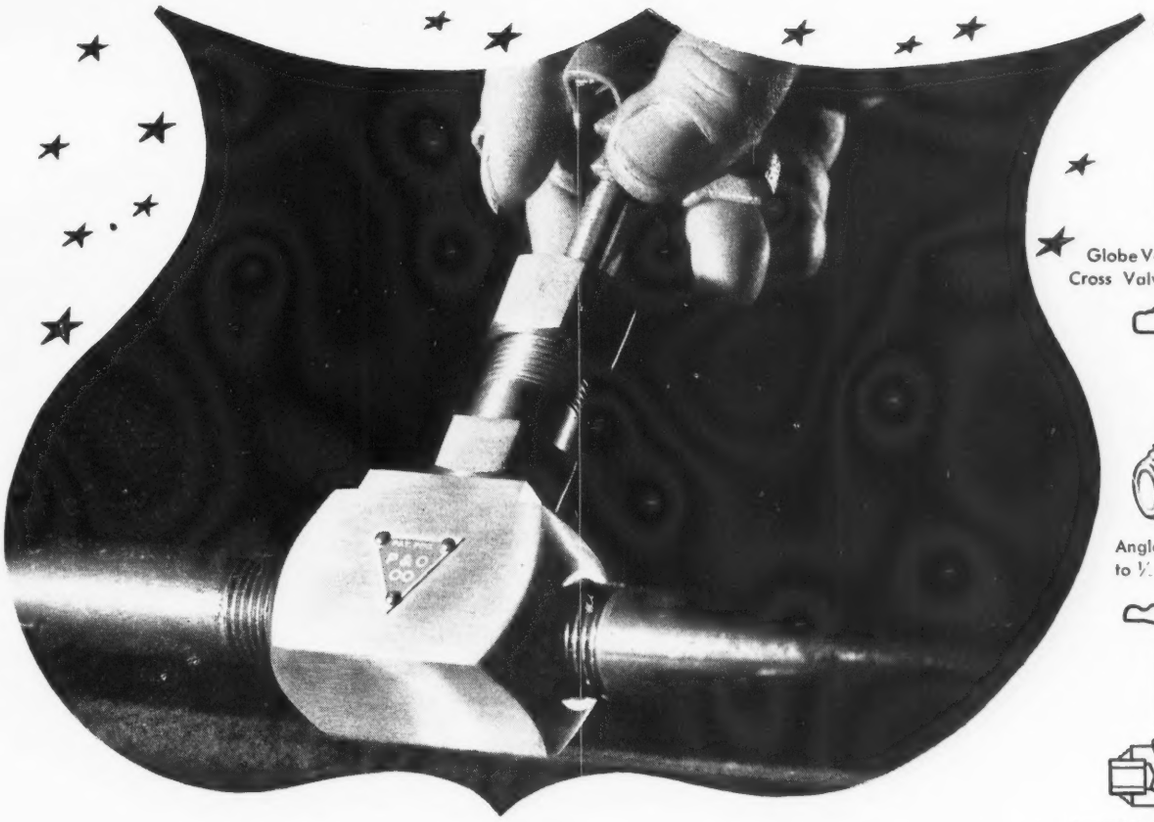
Heat Engines

HEAT ENGINES (Fifth Edition, 1941) *By John R Allen & Jos A Bursley, respectively late Professor of M E and Professor of M E at University of Michigan. Published by McGraw-Hill Book Co, Inc, 330 W 42nd St, New York 573 pages, 6 x 9 in. Numerous charts, tables, photographs, drawings and numerical problems. Cloth binding. Price $4.00*

First published in 1910, Allen & Bursley now goes into its fifth edition as an "old standby" of engineering education. Designed primarily as a basic textbook for students of power engineering, it also contains much of interest to the practicing power engineer who desires to brush up on the "figuring" end of his job without going too deeply into mathematics and theory. The following chapter headings will give an idea of the scope:

Heat, Elementary Thermodynamics, Properties of Steam, Calorimeters and Mechanical Mixtures, Fuels and Combustion, Boilers or Steam Generators, Boiler Auxiliaries, Steam Engines, Power and Performance of Steam Engines, Steam Turbines, Condensers, Air Compressors and Refrigerating Machinery, The Internal-Combustion Engine, Fuels and Fuel Systems, Auxiliary Systems, Rating and Performance, Economy of Heat Engines.

In the new edition particular attention has been given to the chapters on Boiler Auxiliaries, Steam Turbines and Internal Combustion Engines. Sections of the Keenan & Keyes Steam Tables have been included.



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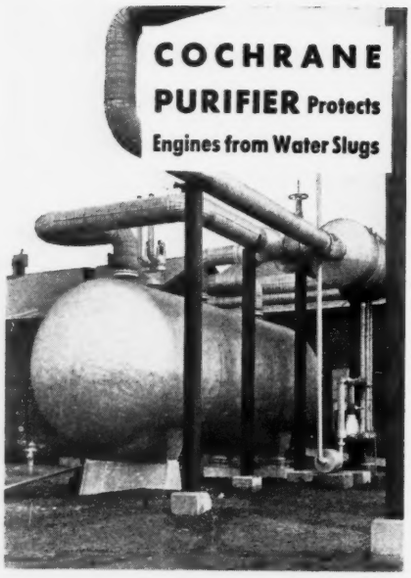

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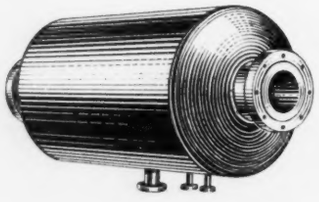

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CATECHISM OF ELECTRICAL MACHINERY (1941). *Published by Fairbanks, Morse & Co, 600 S Michigan Ave, Chicago, Ill. 48 pages, numerous photos, drawings, etc. Paper bound, 8½ x 11 in. Available gratis on business letterhead.*

This book is a veritable "Catechism" of electrical machinery, written so that those not familiar with terminology and fundamentals of the electrical phenomena can get a working knowledge of the same.

Although illustrated with Fairbanks-Morse equipment, it contains practically no reference to either the company or the product throughout. As a matter of fact, only one page, the last in the book, refers to a brief history of the company.

It begins by explaining electricity and magnetism as utilized in electric generators and motors, and goes on to discuss important electrical measurements. Principles of direct-current generators and motors are presented next, followed by a minute and basic examination of alternators and alternating current motors. Diagrams and photos bring out the explanations with clarity.

Brief Reviews

BOILER ROOM INSTRUMENTATION AND AUTOMATIC COMBUSTION CONTROL—*Published by the Hays Corp, Michigan City, Ind. First ten of a series of engineering monographs dealing with about subjects. Available on request.* Consist of articles dealing with instrumentation and control. Series to date includes "How Close Can Steam Pressure be Controlled." "Why Operate Automatic Combustion Control From Changes in Steam Pressure." "Adapting Automatic Combustion Control to the Characteristics of Underfeed Stokers"; also adapting the same control to traveling-grate stokers, spreader-type stokers, pulverizers and oil burners; "Draft—What, where, how and why." "The A B C of CO_2." and "Automatic Combustion Control and its relation to lower steam costs."

TAX FACTS AND FIGURES—(First Edition. 1941). *Published by the Tax Foundation, 30 Rockefeller Plaza, New York, N. Y. 74 pages, paper bound. No price listed.* Consists of statistical and graphical summary of data relating to Federal, state and local finances. Widely scattered facts on tax collections, public expenditures and public debt assembled into one place, and the financial operations of 175,000 governmental units are condensed into this volume.

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